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AGRICULTURAL ENGINEERING

The Journal of the American Society of Agricultural Engineers

APRIL 1928

The Contribution of Engineering to Agriculture - - - - - - - *O. B. Zimmerman*

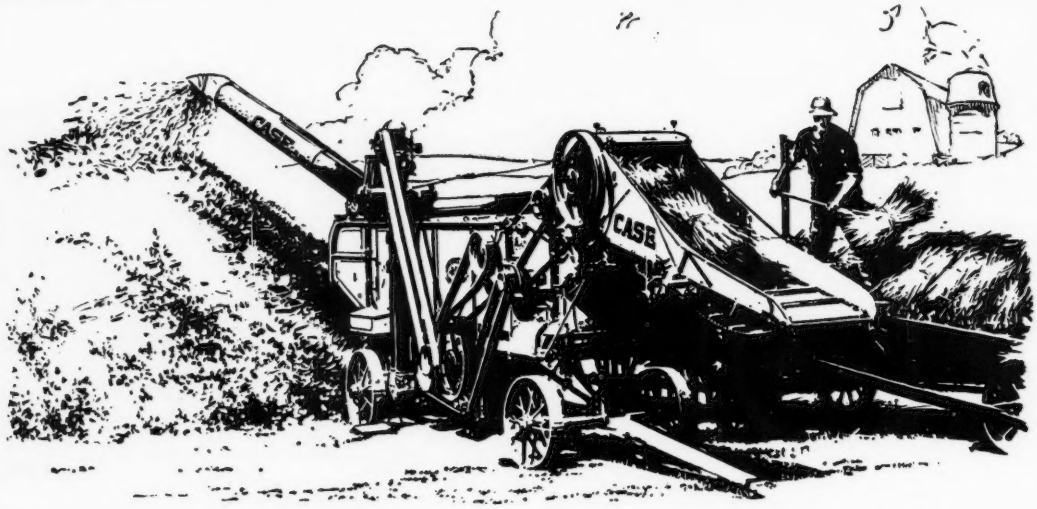
Cutting Labor Costs by Well-Planned Buildings - - - - - - - - - - *P. E. Grubb*

The Electrical Method of Processing Milk - - - - - - - - - - - *J. C. Fetterman*

Some Practical Experiments in Silt Control - - - - - - - - - - *A. F. Whitfield*

Results of Mole Drainage Experiments in Michigan - - - - - - - - - *O. E. Robey*

Some Recent Developments in Tillage Machinery - - - - - - - - - - *F. A. Wirt*



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O. B. ZIMMERMAN, President **RAYMOND OLNEY, Secretary-Treasurer**

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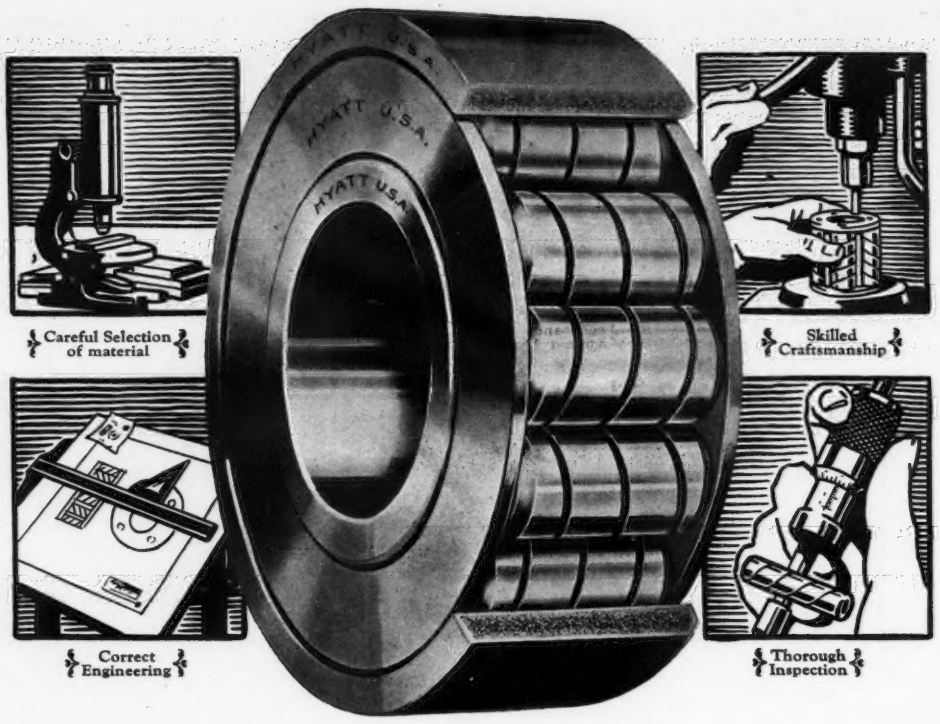

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AGRICULTURAL ENGINEERING

Vol. 9 APRIL, 1928 No. 4

The Contribution of Engineering to Agriculure*

By O. B. Zimmerman[1]

President, American Society of Agricultural Engineers.

AGRICULTURAL engineering will take and hold its place as a prominent science because the problems included within its scope are so many, so varied and of such importance to the advance of civilization. The work in this department of engineering is not as clearly defined in the public mind and perhaps its functions are rather vague to many members of the profession engaged in other branches of engineering. A review of some of its activities and accomplishments may therefore be timely and worth while, both for ourselves as members and for others interested.

Agriculture means, to most minds, a mode of living apart and distinct from the city dweller's life. Its activities are limited, in the urban mind, to the raising of crops from the soil, with livestock, poultry, dairying, etc., as side issues, all done in a small and highly individual way. Hence, the problems in connection with agriculture are popularly deemed unworthy of engineering attention. Size, however, does not mean everything in either industry or science. There may be back of a small product a vast amount of engineering skill, equipment, management, capital, all necessary to its production. A watch is a small article, yet behind its successful production there is a story of engineering that is none the less magnificent because the product is so minute.

Agriculture in the larger meaning of the term has a much broader scope than is popularly believed. The area on which it operates in the United States can be well pictured from data of the U. S. Department of Agriculture covering present and potential farm land areas. These data loom large; speaking in approximate figures only, they show that we have a potential area of 803 million acres. The thought of handling so great an area successfully cannot but appeal to the imagination as being full of important engineering problems. Of this total area the present improved land in farms consists of 503 million acres of which 72 per cent, or 365 million acres, is in crops.

As we investigate the difference between the 503 million acres actual and 803 million acres potential farm lands, we find that most of it is subject to reclamation in various ways. Large areas of swamps, marshes, lowlands and overflowed lands can be reclaimed by drainage ditches, tiling, levees or other measures and making an additional 30 million acres available for cultivation. The agricultural engineering phase of this problem is not only the removal of the excess water or protection against overflow, but also doing it in such a way and to such an extent as will leave the land productive in the highest practicable degree. This requirement involves certain refinements which are truly in the province of agricultural engineering. It involves an intelligent understanding of soils, the movement of ground waters and their relation to plant growth—which problems are far from superficial.

Again, much in the way of machinery is required for these operations, whether it be the simple, economical devices for smaller users or the large excavating machinery necessary in more extensive projects.

Other areas referred to as reclaimable are too dry for production purposes, and the engineer's problem is to devise ways and means of supplying the needed water. The water must be distributed in a satisfactory manner with respect to quantity and time to meet specific needs of the area, soil and crop. The potential area available for reclamation by irrigation comprises another 30 million acres.

Unimproved pasture and range land has an area of 130 million acres, three-fifths of which, or 78 million acres, may be made available for dry farming.

Cut-over lands subject to clearing and drainage would, if reclaimed, add another 60 million acres, while cut-over lands subject only to clearing would furnish us with 50 million acres.

*An address before the meeting of the Southern Section of the American Society of Agricultural Engineers, at Memphis, Tenn., February, 1928.

[1]Assistant to manager, experimental and engineering departments, International Harvester Company.

An all-purpose tractor with a mower attachment, operating a hay press

Drilling at night with a spotlight-equipped tractor. Some farmers have even expressed themselves as preferring to do certain jobs at night

To summarize, our potential new usable areas to be reclaimed are as follows:

By drainage alone	30 million acres
By irrigation	30 million acres
By dry farming	78 million acres
By clearing and drainage	60 million acres
By clearing alone	50 million acres
Balance remaining as range land but improved	52 million acres
Total	300 million acres

It is of course to be understood that present necessity does not warrant the carrying out of the entire program, nor does it seem likely to be attempted within the next generation, but it is certain that selected areas will eventually be reclaimed along the lines indicated. These projects must and will be handled by the best agricultural engineering methods available at the time they are undertaken.

The arguments against any large extension of our production areas are obvious. Our first efforts, it is maintained, should be to develop and encourage methods of increasing production per acre. In fact, the point can be successfully argued that we could produce even more than we need in the way of crops on much less land than is now under cultivation. It is likely that there will be adjustments for economic reasons which will shift interest and effort from less desirable areas to the more desirable, and there will be shifts of interest from one crop to another, just as we have seen in the past. The problems of such adjustments will be full of opportunities for the agricultural engineer.

Flood control and prevention is a live question today. It is receiving well-merited attention but in the main must be handled scientifically, whether the immediate problem be large or small. It is quite obvious that this problem calls for engineering skill of the highest order. Whatever the solution of our principal flood control problem in the Mississippi Valley, agricultural engineers will doubtless have a very definite part in the plan and execution. In studies of this problem which are well under way, attention is being given to methods of holding back the run-off over large areas, including reforestation. Regarding reforestation, we well know the divided schools of thought, but there is a perfectly obvious difference between nature's supply in this regard and a studied, well thought out and executed plan. If these methods lessened the flood climax even 10 per cent, they would accomplish much.

Soil erosion and silt control have largely been left to haphazard methods but are now being studied with care. It is now known that losses to the production value of the land from erosion are far more serious than has been heretofore believed; hence, these control methods must be advanced to the point of good practice. Methods already devised have influenced markedly the wash-away, the gulching, and similar soil movements adversely affecting agriculture.

The engineering of farm structures has had some part in the success of agriculture, and is due to play a much more important part. In pioneer days and for years following it was not to be expected that buildings would provide more than shelter in a rough form, but this condition has been and will be greatly changed. Many such structures erected in our present day have been located, designed, constructed and utilized without full thought of the optimum requirements. In fact, there has been little available information or analysis applied to the fundamentals of these structures until very recent years.

The Structures Division of the American Society of Agricultural Engineers has organized this important work, and as a result some splendid examples of design and some fine papers on the subject have been produced. As it is disseminated, this information will aid in the wider incorporation of important elements in future farm structures. Building design, materials, construction, heating, ventilating, water supply, sanitation and fire protection and prevention need and will receive more attention from those engaged in agriculture.

Crop storage has many problems still unsolved, but the basic principles underlying successful storage are being established. Temperature, ventilation, methods of handling, etc., are among the factors receiving attention.

A review of the approved designs and their recorded effects upon the efficiency of even such small structures as poultry and hog houses makes us wonder why scientific attention to them was so long delayed.

So much has been written about the relation of power and machinery to agriculture's success that it would seem unnecessary to do more than outline these features here. No division of agricultural engineering deserves or has received so much attention as farm machinery. As a result, America remains supreme, not only in the farm implement field but also in farm operating methods.

We have seen soil preparation machinery develop from the single-share, horse-drawn plow to the multiple or gang plow, tractor-drawn, with many refinements and differentiations of shape and provisions for adjustment. New material and its heat treatment have been incorporated. The disk types of plows have been refined in a similar manner for their specific purposes. Subsoilers and grub breakers are examples of tools developed for special purposes and conditions. Surface tillage implements in their various forms of harrows, disks, soilpackers, have been greatly refined. Planting machinery for various grains and seeds has attained a high degree of efficiency in method and result. Power cultivation of row crops has been more recently attained by a new adaptation of the tractor, thus making one more notable advance in speed and economy.

For many years orchards and plants have been sprayed by simple mechanical equipment. Here, too, the tractor has simplified and speeded up the operation and reduced the cost.

The boll weevil and the corn borer are now receiving their full share of mechanical attention by agricultural engineers, and some others, like the Japanese beetle, are apparently due for like consideration.

Machinery and methods for speeding up timothy, clover, and alfalfa hay making and handling have reached a point comparable with the best records in other farm operations.

Harvesting of grain by means of the harvester-thresher has been developed to a stage where this method is being applied widely, far outside the areas that were originally thought to be the natural and only logical place for this type of machine.

Taken generally, up-to-date farming machinery has reached a point so far ahead of thirty years ago that competition between the older types and the new is out of the question where mass production is the aim.

In South Africa, for example, it takes 80 to 90 oxen, driven by ten men, to plow 10 acres of land in a day—and to keep the oxen in pasture requires 900 acres. Contrast this with a three-plow tractor unit with which one man can do the same job in eight hours. A record for tractors worth noting is that of a farmer with a 15-30-hp. tractor who plowed 110 acres in 5½ days. This man's best record with a six-horse team was 30 days for the 110 acres.

A review of machinery progress would not be complete without reference to the materials of construction and the advances which have taken place along that line. To visualize this quickly, note what has been done with the ferrous products. Starting with iron in its simplest form and used as iron castings, we have an average tensile strength of 15,000 lb. per sq. in. By refining processes this material can be variously handled, processed, or alloyed until in its various states as iron or steel its strength can be increased to 360,000 lb. per sq. in., the latter in the form of extra quality crucible steel wire. What a choice for the designing engineer.

The various desirable qualities of the ferrous products are now completely under control. If we desire hardness, we have a wonderful range from soft to glasshard; if we desire machining qualities, we find that factor well under control; if we desire forging or drawing qualities, they too are at our command.

The dominating position of the internal-combustion engine in the recent advance of power farming leads us to consideration of liquid fuels as having a vital part in engineering and successful agriculture. But for marked advances in the production of fuels, much of the program of machine development would have been appreciably delayed. The combined efforts of engineers in producing satisfactory engines and the chemical engineers of the oil industry in providing suitable fuel have enabled us to effect ever increasing economies. Some years ago a heavy plow operating with a tractor required four gallons of fuel per acre for a given accomplishment, whereas now the same operation runs as low as two gallons. Lubricants likewise are much improved, with qualities provided for all reasonable requirements.

We could recount many other advances of successes which have come about through the application of engineering to agriculture, but instead let us imagine a parade of a few of the latest and most powerful machines available for farm operations. It should be remembered in this review that in designing new machines for agriculture, attention must constantly be given to the reduction of farm operating costs. At every point of comparison with current equipment, the new agriculture must show lower labor costs, lower overall power costs, fewer man-hours required, higher speeds of operation, higher efficiency.

The all-purpose tractor leads the procession because mechanical power is essential to modern farm operation. The tractor is a balanced power unit capable of operation twenty-three hours a day, with one hour a day allowed for care, refueling, lubrication, renewal. Equipped as it can be for spring, summer, fall or winter operation, and supplied as it can be with modifications of successful devices covering all farm operations, it furnishes power by belt, drawbar, or power take-off. It is a marvel of effectiveness.

Tractor plows, disks and listers developed for all logical requirements where deep tillage is desired come next. These outfits will do the equivalent of from six to twelve man-and-mule units. The lister cultivator readily finishes twenty-five acres in a ten-hour day.

The harrow plow is a new tool of agriculture, serving the purpose of both plow and disk harrow where moderate depth of pulverization and mulch are desired and where high speed operation is important. It is a markedly efficient weed killer. Twenty acres a day is readily prepared with it.

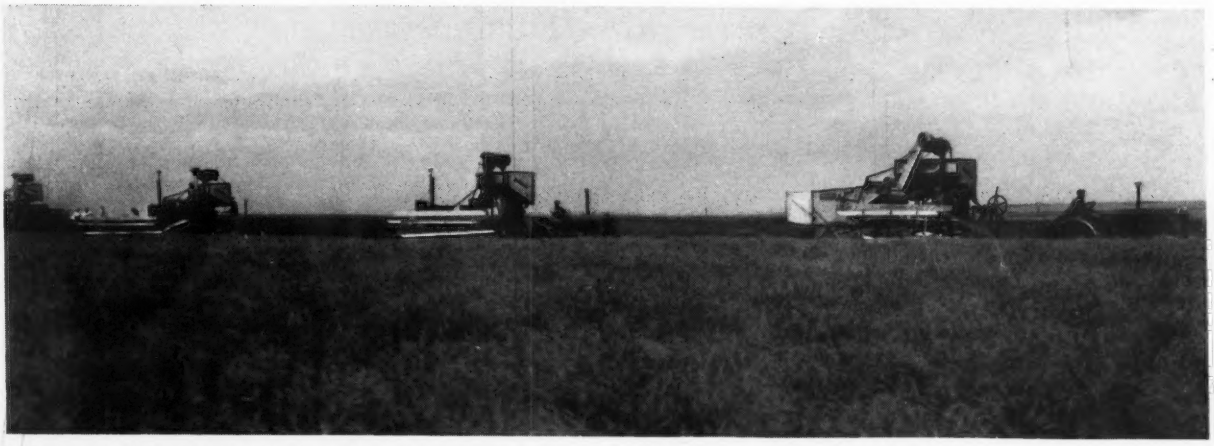
The wide type disk harrow for the wheat belt where summer fallow cultivation is desired comes next. Forty to seventy acres a day is handled by this unit, sweeping the field in twenty-one-foot strips.

The two-row and four-row planter puts in corn and cotton at rates of from twenty to forty acres per day, respectively.

Another important tool is the rotary hoe, devised for thoroughly stirring the soil or for breaking the crust following rain and heat. The cultivation of soybeans, corn, beets, mint, etc., can be carried on with it even after the plants are well up. The twenty-nine wheels, each with sixteen points, thrust 464 holes in every six feet of travel. Unusual stimulation of the crop is noticeable after this operation. Two seven-foot sections of this rotary hoe drawn by the all-purpose tractor cover fifty to sixty acres per day.

The all-purpose tractor unit with a cotton dusting attachment operating six rows wide, next attracts our attention. It covers the ground at the rate of one hundred acres in ten hours.

The motor truck passes next, the legitimate and logical successor of the farm wagon. Already over a quarter of a



A battery of McCormick-Deering Combines at work, as seen from the grain side in one of Oscar Linn's fields of wheat near Kimball, Nebraska. Oscar Linn, Vernon Linn, and Frank Linn farm over 8,000 acres of wheat. These three brothers own ten tractors and eight harvester-threshers. They operate entirely without horses

million of these useful transport units are serving their owners, the farmers of the United States. No all-night ride with horses to deliver partly wilted produce to market is needed today. The farmer now can haul by motor truck at thirty miles an hour over good or even fair roads.

Here come the haying tools—an all-purpose tractor with seven-foot mower attachment. This combination is capable of cutting fifty to seventy acres of grass a day. A side-delivery rake to windrow the hay and a hay loader represent the equivalent of hundreds of backaches of the past.

Next in our parade appears the wonder farm machine of the day, the harvester-thresher. At one time restricted in use to the semi-arid West, it has widened to the Southwest, and North and the East, even into Canada. Our better understanding of its uses and of the question of permissible moisture content in stored grain has opened wide a door formerly closed by a mere notion. Its possibilities range from twenty to forty acres a day. Savings vary according to conditions, but may be said to range from 15 to 20 cents per bushel.

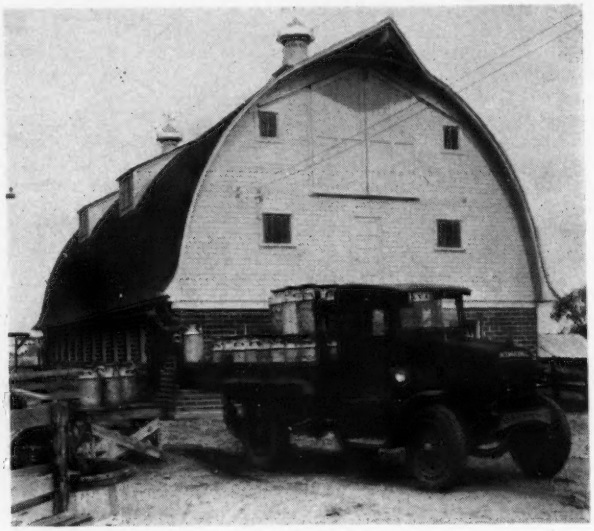
The two-row corn snapper is before us. Twenty men would have to hustle to equal its performance by hand. Twenty acres a day make the choice of operating days an important element in its prospective popularity.

The field ensilage harvester is an implement bound to take a more prominent part in areas where ensilage is used and where dairy operations are extending, as it markedly reduces the expense and eliminates backaches of the usual practice. Six to eight acres of corn can be harvested and put in the silo in ten hours.

The stubble pulverizer is another new implement that was easily adapted to meet the emergency requirements of corn borer control. This farm tool has been found useful in the destruction of cotton stalks as well as corn stubble so they do not interfere with cultivating and rendering them useful as fertilizer. The work of this implement can be carried on at the rate of twenty to thirty acres a day.

In the old days of hand farming one man could, with difficulty, perform all needed operations on a farm of 20 acres. Today, with modern equipment, one man alone can operate 160 to 320 acres, according to his crop. In listed wheat territory, with tractor power, one man can handle 320 acres and not work more than 100 to 152 days a year. With five men and five tractors equipped with 14-inch bottoms and traveling at the rate of three miles per hour, a farm of 640 acres can be plowed in twelve days. Formerly five men and ten horses took sixty-four days to cover the square mile.

Corn cultivation has always been one of the slowest, meanest, hardest jobs in farming—a hot and dusty task, as exhausting to the farmer as to his horses. Under horse power cultivation, the single-handed farmer has all he can do to take care of 40 acres of corn. With the all-purpose tractor he can handle 125 to 150 acres, and with such a tractor and a lister cultivator he can easily handle 250 acres.



The jobs that the motor truck is faithfully performing are manifold and are increasing in great numbers. In the hauling of milk especially it has speeded up deliveries. Here is shown a 1½-ton international motor truck owned and operated by Harry Marsh, Carlisle, Iowa, who regularly hauls milk to the Flyn Dairy, Des Moines, Iowa

Grain can be planted or harvested with mechanical power regularly and easily at the rate of 25 acres a day per man; 50 acres per day can be covered under pressure. One man with three boys handles nearly 2,000 acres of Kansas land, year in and year out. These examples definitely indicate the progress which engineering has made in mechanizing agriculture.

Time does not permit more extended discussion of other important phases of engineering's contribution to agriculture's success, but the entry of its activities within the home must not be overlooked, for there too it is making material progress. Every engineer should be glad to aid in the fine work that is being done to lighten the burdens of the farm housewife and to make the farm home a place full of contentment, a place where drudgery is set aside by conveniences the like of which were unknown to women of the past. Electricity is playing and will play its part in sanitation, light, health, comfort, convenience and contentment on the farm to a degree we do not now realize. Valuable researches going on under the watchful eye of home economics experts and of a strong group of sincere women working in cooperation with engineers are bound to advance American home life on the farms.

Corporation Farming

ASIDE from the trek from farm to city, the subject of increased size of farms and corporation farming has probably come in for the greatest amount of discussion of the more strictly economic and social phases of American agriculture during the past year or two. Will we have corporation farming in the future? What will be the effect on the economic and social life of the men and women so employed? The first question can be simply answered in the affirmative, for we already have corporation farming.

There seem to be two distinct trends in the size of farms. One is toward the small subdivision plot near cities, used for a country home or "play" farm; and on the more practical farms, toward the smaller unit operated entirely by the owner. The other, more noticeable and widespread, is toward larger farms which allow the more efficient application of larger units of modern labor-saving machinery to bring about a lower production cost and an acceptable profit, through the multiplication of a small margin by a large number of units, whether it be bushels of grain, pounds of livestock, dozens of eggs, or gallons of milk.

From observations of the social effect on workers employed on corporation farms, there seems to be little indication that the result is depressing or harmful, either to the worker or to the community in general. For example, a large estate in a midwestern state employs 40 men, all married. Each family is provided with a bungalow with running water and electric lights. Each morning a gallon of milk is brought to the door. Each family has a garden plot for its own use. Busses take their children to a community school. The actual cash wage paid is not large, but is large enough to enable each family to save.

The ideal situation, of course, from the traditional American viewpoint, would be for every farm to be operated by an owner who lived on the farm. There are thousands of cases, however, of people who like and want to live on the farm but who do not have sufficient managerial ability to operate a farm at a profit. These people may find the greatest success by working on a corporation farm managed by an agricultural engineer.

Cutting Labor Costs by the Efficient Planning of Farm Buildings*

By P. E. Grubb[1]

THE importance of this subject is due to at least two very good reasons: The results obtainable by the efficient planning of buildings, and the utter disregard of all principles of buildings efficiency on a great number of our farms today. Especially is this true if the farm set-up has been established for some time, but it is by no means confined to this class alone. In fact, the average farmer has taken advantage of the use of modern machinery to a much greater extent than he has attempted to cut down his labor costs by well-planned buildings.

In conversation with a farmer friend the thought was mentioned that it would be a fine thing if a farmer had no chores to do. To the grain and livestock farmer stock feeding is to a great extent the liquidation of the year's work in the fields, the turning of his crops into cash. Though his yields be high, if this operation is carried on wastefully of feed or labor, the results of the year will be jeopardized. So if we cannot eliminate chores, cutting the labor to the minimum is greatly to be desired.

Before discussing the planning of the buildings themselves, it is well to consider a few things about their grouping and location on the farm.

It is the consensus of opinion that the efficient farmer cannot hire field help to create energy; he must use it to direct energy. But in a great many instances that same help is employed around the barns in the role of a pedestrian. This can be well demonstrated if we will take particular notice of farm layouts as we drive through the country. Here a barn some fifteen or thirty rods from the house; there a small farm with buildings widely scattered; or a farm whose water is supplied by a wind pump in some out of the way place, simply because some individual claimed to be able to witch for water. These are typical examples with which we are all familiar, each one standing out as a monument to the inefficiency of the one responsible for it.

We can no more expect good results from such examples, than we can expect modern incomes from farming the way our forefathers farmed.

Personally I believe one hundred to one hundred and fifty feet is the right distance between the house and barn. This depends somewhat on the direction of the house from the barn, the arrangement of the interior of the barn, the natural setting and the direction of the prevailing winds.

Allowing fifteen trips a day from house to barn for the entire family, each step farther apart they are placed means an extra six and one-half miles per year. Not such a long distance, it is true, but too long if covered for nothing.

The usual list of farm buildings, including corn cribs, wagon house, granary, hog house, dairy and horse barns, shop and garage, may be constructed as separate buildings or incorporated into one or two units. Each system has its desirable features as well as its undesirable ones.

The greatest advantage of separate units undoubtedly is the lessening of the fire hazard, while the disadvantages from the same method are the higher first cost and maintenance and the inconvenience due to longer distances traveled when going through the regular routine of chores.

The handwriting on the wall seems to point more and more clearly to the industrialization of the farm. I believe that as this comes about we can but follow its example of housing most of our feeding under one roof, believing a dollar will buy more in the form of insurance than it will in labor. At present figures every ten hours saved per year in doing chores will more than justify $1,000 additional insurance.

In planning the exterior and floor plans of our farm buildings many things must be kept in mind, such as the products, the size of the farm, combining utility with beauty, and the necessity of doing the work with the least expense of labor.

A certain factory, which was supposed to be well-organized, found by the work of an industrial engineer that sixty per cent of its wages were paid for walking. With this example of inefficiency where it was least expected, let us be quite certain we are accomplishing the most with the least number of steps.

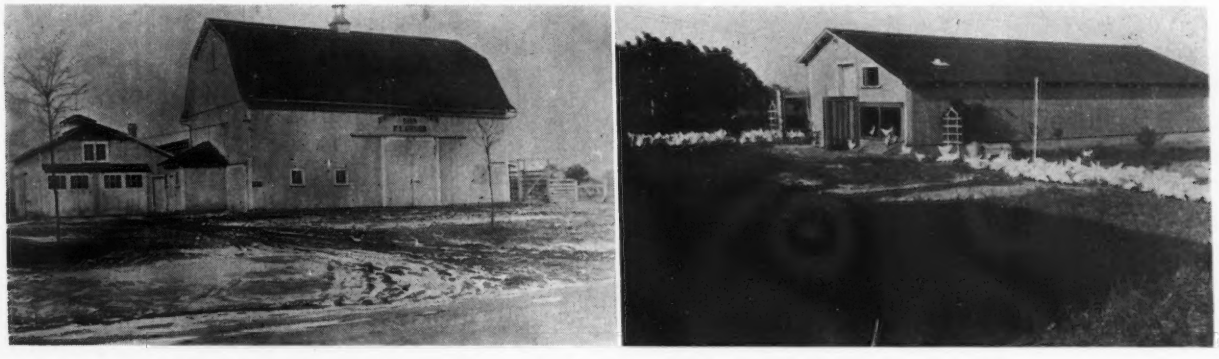
As it is quite essential that our livestock should have an abundant supply of water at all times, let us place the pump, if running water is not available, at a very convenient place—close to the barn, or better in it, where we pass many times each day. This location, together with a frostproof and complete distribution system, will save many steps each day.

Our experience with wind, gas engine, and electric-driven pumps has taught us the last named to be the most satisfactory, even though the current has to be generated at home.

Arrangements of the quarters for the several kinds of stock must be decided upon by the individual, remembering that it is much less expensive to revise on paper than after the building has materialized. One must keep in mind such things as the location of the dairy to make it comply with city regulations, the sleeping and feeding quarters so as to be convenient to beddings, feed, and the removal of litter, and the cribs and feed bins as to being filled and feeding the stock.

*Paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers, at Chicago, December, 1927.

[1]Owner and manager, Bonnymead Farm, Johnstown, Ohio. Assoc. Mem. A.S.A.E.



(Left) View of Mr. Grubb's main group of buildings. (Right) Poultry house on Bonnymead Farm

Mr. Grubb takes every advantage of modern labor-saving equipment to "industrialize" his farming operations

One principle often overlooked is that the vertical movement of straw or roughage is the most economical of time and labor. Therefore, we place a supply of loose straw over or near the sleeping quarters of the hogs and other stock. This is the best assurance that they will have fresh bedding when needed, much more often than if it were necessary to dig it out of a wet stack and carry it through the mud.

In a carefully planned barn we find some provision for protecting all litter from the weather until it may be hauled to the field. On the average farm keeping a dairy of from six to twenty cows, the providing of a milking parlor, and enclosed yard where the animals are kept except when being milked, seems to take care of this and also reduces the labor of handling the litter twice.

A special point to keep in mind is the providing of light, direct sunlight if possible, to all parts of the building. This together with a carefully worked out system of electric lighting will do much to speed up work. It has been said that one who checked operations with a stop watch found that thirty per cent of the time doing a certain work could be saved by the use of electric lights. A factory would go bankrupt in a short time if it used the lighting methods found on a majority of our farms today.

In designing our buildings we must plan to use as much labor-saving equipment as possible. An authority on farm practices has said, "The American farmer has all the machinery necessary for industrialization; it is merely a problem of making greater use of it." Motorizing an operation often saves the work of a man, while the use of feed trucks, feed elevators, gravity feeders and litter carriers will do much to lessen the labor item.

In conclusion, may I state that the farmer of today is looking to the state experiment farms and universities as the research department of the agricultural industry. After a desire is once developed within to better his condition and standard of living, he is receptive to new methods of doing things, if he can but see the greater results.

In our state it has been found out that more people improve their methods of farming due to the influence of the community at farmers' institutes than any other branch of extension activity. These institutes have increased in number and attendance over seventy per cent in the last ten years.

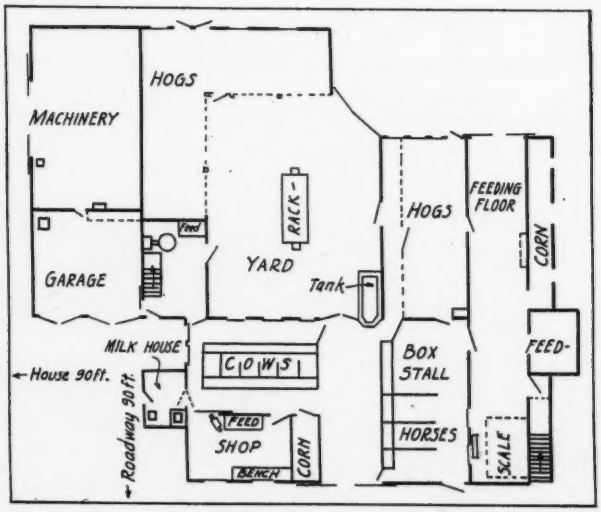
A Practical Engineering Course for Farmers

COME whenever you want to study one or more problems of your own choice, take no examinations and leave whenever you please is, in substance, the broad invitation which the rural engineering department at Cornell University extended to the farmers of New York state last year.

"Learn to do by doing," the advice of the department to the farmers, describes the course in a few words. Farmers could come any time between November 9, 1927, and February 11, 1928, and, under the roof and guidance of the department staff, work on one or more practical problems along the lines of farm carpentry, harness, gas engines, explosives, farm blacksmithing, rope work, soldering, plumbing and water systems, drainage, concrete, power transmission, tractors and trucks, and farm machinery.

Farm machinery was studied from a somewhat different angle than the other subjects. It was taken up from the economic standpoint, represented by such problems as: (1) How much machinery should any farm have; (2) How much corn must a farmer raise before he saves money by cutting it with a corn harvester rather than by hand; (3) What new machines coming on the market are likely to be a good investment on New York farms; and (4) What size of farms make possible maximum use of machinery?

The department feels that the course was a success and will offer it again next winter. About a dozen young farmers came this winter and brought in machinery on which to work. One brought in a grain drill in bad condition, a binder that had been run away with and a tractor in need of general overhauling. He stayed ten weeks, put his machines in first-class condition, painted them up like new and learned a lot at the same time. The others did similar practical work and all were well satisfied with the course. So far as the department knows, no similar opportunity has ever been offered to farmers anywhere in the country.



Ground plan of buildings on Bonnymead Farm. Efficient planning of buildings on this farm has resulted in greatly reduced labor costs

The Electrical Conductivity Mothed of Processing Milk*

By J. C. Fetterman[1]

THE dairy industry is not unlike many other industries that meet modern demands through the utilization of new principles and new processes. The problem of bringing to doorstep of the city dweller fresh, safe milk, adequate for the needs of a growing family, is a problem that has received the unremitting attention of scientific men trained to deal with this intricate situation.

The introduction of the process known as pasteurization has been rightfully considered one of the epoch-making events of the twentieth century in effecting an advance in the better handling of milk. Despite the advantages of pasteurization, the introduction of this method was bitterly opposed by many influential leaders who failed to recognize the merits of the process, as a means of eliminating bacteria responsible for various diseases.

In the last two decades, scientists interested in dairy operations have pointed out the possibility of utilizing the electric current as the basis of a method for processing the milk supply for our teeming centers of population. The hope had been frequently expressed that such a method might be devised possessing greater simplicity than the pasteurization process and at the same time producing a more satisfactory product.

The pathway blazed by these scientific investigators terminates in the perfection of a method of safeguarding milk, the electrical conductivity method, which today constitutes one of the outstanding achievements of modern dairy science.

The well-known pasteurization method, which up to the present time, has been the best method of processing milk supplied to the great centers of population requires that the milk be heated in vats at a temperature of 145 deg. F. for a period of 30 min. It is with this method that comparison is to be made of the electrical conductivity method popularly known as the "Electropure Process." This process involves the application of the electric current under conditions such that the temperature of the milk is raised to 160 deg. F. after which the milk is cooled to the bottling temperature, which is a few degrees above the freezing point.

The actual operation of the process is extremely simple. The milk passes up through a vertical rectangular opening in the center of the Electropure unit, which is the essential part of the apparatus, two opposite walls of which are carbon electrodes. The milk, as it passes through this apparatus, conducts the current from one electrode to the other. Certain elements in the milk offer sufficient resistance to the current to generate the amount of heat required. It is thus seen that this method differs radically from the pasteurization process.

Through the operation of automatic devices, the temperature at which the milk is processed, as well as the rate of flow, are automatically controlled. Incidentally, it is worthy of note that in the processing room of a modern dairy plant, equipped with units of the Electropure apparatus, milk is nowhere exposed to view, thus eliminating all possibility of human contact. The electrical generation of heat, the automatic control of various phases of the operation, the freedom from human contact are points which present a strong appeal to those interested in promoting higher standards of health.

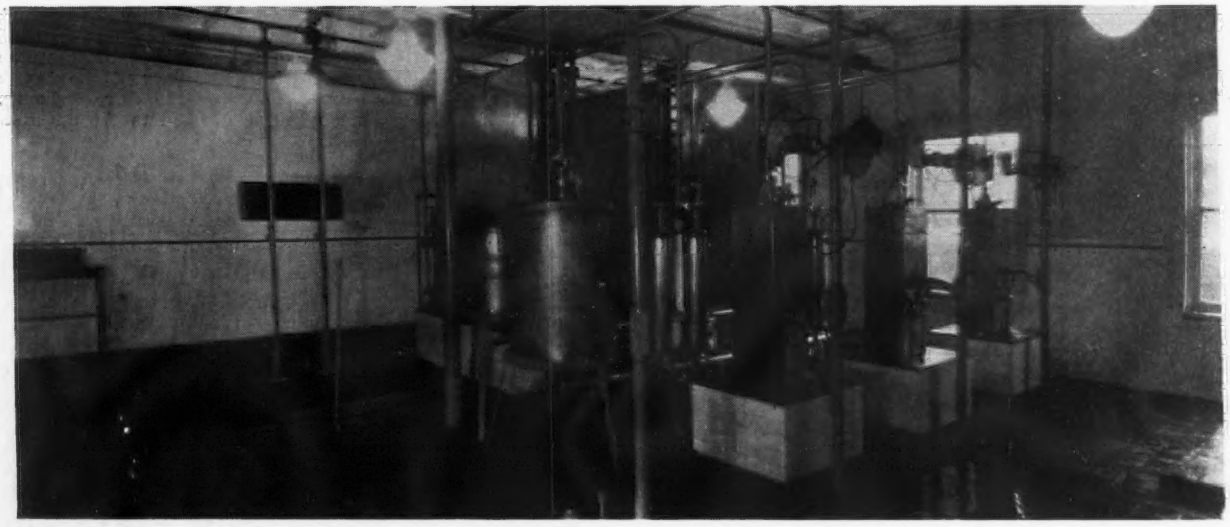
While the purposes of the two methods are similar, scientific study reveals that the Electropure process posseses outstanding advantages over the pasteurization method. First, it is to be noted that the Electropure process positively destroys tubercle bacilli, which, of itself, represents a marked advance over methods tried heretofore.

While the greatest importance attaches to the destruction of tubercle bacilli, it is also important that this method likewise destroys organisms in milk which cause acute infectious diseases, as has been proven by careful studies of competent investigators.

Various studies of the action of the Electropure process on pathogenic organisms have been carried on in this country as well as abroad. Of the investigations made in this country, mention should be made of those conducted by the departments of health of the states of Pennsylvania and Michigan; also the investigation conducted by Dr. Samuel C. Prescott

*Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Pittsburgh, Pa., October, 1927.

[1]Director, National Certification Laboratories, Pittsburgh, Pa.



An installation of three units of the Electropure apparatus in the processing room of one of the large dairies in Pittsburgh, Pa.

of the Massachusetts Institute of Technology. These investigations, together with others equally notable, substantiate the claims which are made for this process.

The following results from a report covering a recent investigation of the Electropure process in its destructive action upon tubercle bacilli, in which experiment suspensions of tubercle bacilli possessing a high degree of virulence were added to raw milk, are of special interest. The milk thus prepared was processed in the Electropure unit at the temperatures 160, 155, and 150 deg. F.

Samples were collected for guinea pig inoculation at the above temperatures. Animals injected with the inoculated raw milk in all cases developed pronounced symptoms of tuberculosis and very early, upon microscopic examination, showed signs of a heavy infection.. The animals injected from samples collected at the temperatures 160 and 155, when autopsied, upon careful microscopical examination involving the staining of preparations for acidfast bacteria, were found to be free from tubercle bacilli. The appearance and weights of these same animals indicated a strong healthy condition. Even at the low temperature, 150 deg., the efficiency of this process in destroying tubercle bacilli was indeed remarkable.

The addition of such great numbers of tubercle bacilli to the milk tested established a condition with reference to the number of these organisms present which would not obtain in the ordinary handling of milk. The point to be stressed here is the remarkably severe test to which the Electropure apparatus was subjected, under the conditions maintained in this experiment.

Another interesting fact noted in comparing pasteurized and Electropure milk is that, while pastuerized milk may frequently possess a cooked taste, the flavor of Electropure milk is found to be similar to that of certified milk or even better.

While it is well understood that the outstanding purpose of the Electropure process and also of the pasteurization method is to safeguard the users of milk through assurance of the fact that pathogenic organisms have been eliminated, it is also demanded that milk shall keep in a satisfactory manner. This demand as to keeping quality Electropure milk meets to the satisfaction of those who have studied this important phase of the problem. While, as stated above, Electropure milk is free from pathogens, nevertheless it contains the desirable lactic organisms responsible for the normal souring of milk.

It is a well-known fact that milk containing the proper amount of butterfat will not develop a sufficient cream line when subjected to the action of heat for too long a period. It is therefore of particular interest in this connection to note that the electrical conductivity method emphasizes the cream line, so that the bottled milk presents an appearance that is very striking.

In the light of the facts science has given us concerning the occurrence and importance of those interesting substances, vitamins, we are vitally concerned in learning the effect which the various processing methods may have upon these substances occurring in milk. This is a question which has been deemed of great importance. Consequently, different studies have been conducted with the result that it is definitely ascertained that, when milk is heated for a considerable period in contact with the air, the vitamin content is impaired. This condition is one that does not obtain with the electrical conductivity method, due to the short heating period and no contact with the air. A very searching study of this question with reference to the electrical conductivity method has just been completed, the results indicating that this process does not impair the vitamin content of milk. This very satisfactory condition places Electropure milk in a unique position as compared with milk processed by heating in vats over a long period.

It has been suggested that the destructive action upon B. Coli might be considered an acceptable criterion in determining the safety of milk. The innumerable tests made of the relative efficiency of the pasteurization and the electrical conductivity methods give positive evidence that B. Coli and associated organisms are readily and completely destroyed by the new method, whereas it is a well-known fact that B. Coli may occur in milk that has been pasteurized.

Referring to the mechanical features of the Electropure Unit and the accessory parts, we can not but be impressed with the simplicity of mechanical construction as well as the simplicity of the electrical operation.

There are no moving parts connected with the heating unit. It makes use of the natural property of resistance to the flow of electric current which is a property of milk and other liquids.

The control of flow to govern temperature is accomplished by means of sensitive, quickly responding thermo couples. From the standpoint of the electric power company, it makes an ideal load since it uses current with practically one hundred per cent power factor.

In considering the electrical efficiency of the unit it is found that an efficiency of 95 to 98 per cent is realized. The only heat which is not utilized is that carried off by the water used in cooling the electrodes. The heat efficiency is high, due to the fact of heating the raw milk with the hot processed milk in accordance with the usual plant practice.

The space required in the dairy plant is only a fraction of that required for the vat system of pasteurization. In one plant where 10,000 gal. of milk are processed daily with this method an area 20 ft. square readily accommodates the entire installation.

With reference to upkeep it can be said that the heating unit requires no attention aside from the daily cleaning and sterilization which are very readily accomplished. The control equipment is after all extremely simple and does not require the supervision of a skilled attendant. It is readily possible for one person to take charge of a battery of as many as three units.

The fact that the electrical conductivity method eliminates all possibilities of foam formation which is often a source of trouble in vat pasteurization, is a very strong point in its favor. That there are no pockets or dead ends favoring the development of bacteria constitutes another point of superiority.

The new method has received the endorsement of the health authorities of various states and is now being operated on a commercial scale in various cities. In the city of Pittsburgh, one company processes 30,000 gal. of milk daily by means of this method.

In conclusion I wish to state that, in the light of the many investigations of the electrical conductivity method, there can be no question but that it meets the most exacting requirements of the dairy industry and is deserving of the fullest recognition and support on the part of the health officials and the progressive minds of the dairy industry, together with the various agencies devoted to the advancement of the national health.

A FARM BUILDING EXHIBIT

The picture shows a farm building exhibit prepared by F. D. Cornell, Jr., agricultural engineer, West Virginia University, for Farmers' Week at that institution, in an effort to stimulate interest in better buildings and better building equipment. The picture shows a model farm layout; the rest of the exhibit consisted of models showing construction details, together with literature on farm buildings. The exhibit stimulated a great deal of interest and discussion.

Some Practical Experiments in Silt Control*

By A. F. Whitfield[1]

IT IS very noticeable that the newly deposited sediments are the most fertile soils of any district. The finely divided clays; the light particles of decaying organic matter, especially when brought by the water from the wooded land, form the bulk of the deposits from slowly moving or still water.

These finely divided particles of soil and organic matter, the salts from the rocks thoroughly mixed by flowing water—especially when lime is abundant—combine chemically with the nitrogen from the air making a rich soil.

There is enough soluble silica in all soils for fertility, except in a few instances of clays and in almost all coarse sandy soils. The reason for the lack of soluble silica in sandy soils is the want of material that renders the silica soluble. I know of one place in the flood plain of a creek flowing from lime hills where a tract of unproductive but fine-looking clay soil was made fertile by a deposit of sand.

Too much sand makes the soil too open and subject to drouth. Too little sand makes the soil too stiff for easy cultivation and unfit for some crops. The regulation of this factor in sandstone regions is the hardest problem of silt control.

In the year 1912, a pond in the center of a new coal mining camp covered about 1½ acres, rendering as much more land surrounding the pond very wet and unsuitable for dwelling places. The outlet was not deep enough to thoroughly drain the pond. A row of houses extending through the middle with fronts facing higher ground was made fairly desirable by filling in walks from the front doors to the street. This street and the walks were raised by hauling in dirt and rocks. Back of these houses a space a little more than a ¼ acre was set aside for a vegetable garden and nearby space for a stable and mule lot. The deepest part of the pond was in the garden, so that less than half of it was fit for cultivation. Level land was scarce. All had to be utilized. And then some houses had to be built on the steep mountain side, one side of the house being put in an excavated place, the other side on stilts.

The water from a mountain stream was turned into the pond. This has filled it to such extent that today a drain tile in the deepest part of the pond is about 0.9 ft. below the original bottom of the pond and about 1.9 ft. below the top of the deposited silt.

To raise this ground still higher to give deeper drainage, and at the same time continue to enrich the soil with the rich mud from a wooded mountain cove, a low embankment is kept around the lower edges of the garden. An outlet is provided which can be opened or closed as desired. For a while too much sand and large quantities of iron sulphate came with the water. This sulphate was gathered by the water flowing along a railroad track where coal mine refuse had been dumped. It required so much lime to correct the toxic effect of the salts from the coal mine refuse, and to get less of sand, that the water of the stream was divided. That which flowed over a 6 in. obstruction was allowed to go into the garden. The other with most of the sand flows over the mine refuse and is wasted.

This lessens considerably the quantity but improves the quality of the silt.

Another small project of 3 acres, a truck patch of which area about 2½ acres can probably be flooded, has been started. The land lies in a trough-mountain on one side and a river with high banks on the other. A deep slough at the foot of the mountain extended more than half the length of the patch. This slough was the ancient bed of the river which changed its source when its bed was filled with rocks and dirt that slid down the mountain side.

A dam across the lower end of the field backs the water over the field 230 ft. to a second dam. The second dam backs the water about 200 ft. The land above the two dams is flooded by a stream bearing fertile silt with the proper amount of sand to make a good friable soil easy to work and containing enough clay not to be subject to drouth.

The land above a third dam or terrace, which will be constructed as soon as time and opportunity will permit, must be flooded with water from another stream carrying too much sand. This will necessitate a trap to waste the sand and allow the better part of the silt to pass into the field.

The slough above mentioned is now scarcely noticeable, the deepest place is now filled to about 8 in. below the adjacent level ground. The soil both in the slough and on the level ground is very productive, especially where well limed.

All of the above-mentioned ground was wet and boggy. The slough dried only in the driest summers. All is now tiled.

Springs issue from the foot of the mountain, some of which are charged with iron-sulphur compounds ruinous to any growing crops. The water from these toxic springs is caught in basins filled with broken rock and led away in underground tiles.

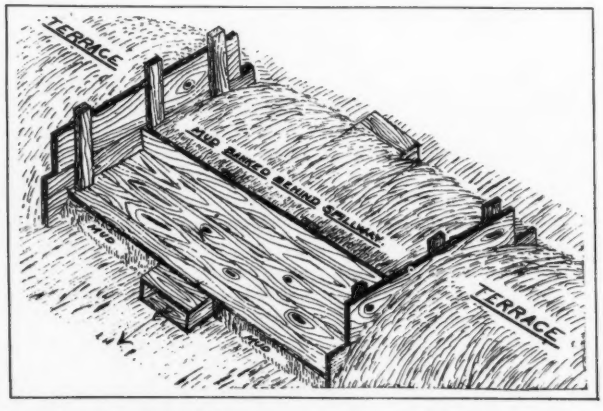
In the Appalachian regions of Kentucky, Tennessee and Alabama are numerous tracts of toxic land, which when drained and properly treated are the most productive corn lands in those sandstone regions. I have gathered and weighed as much as 73 bu. of corn per acre from the whole field where, before treatment, the land was in places covered with bullrushes and water grass, and in other places having absolutely no vegetation, due to the toxic effect of poisonous springs. Results of experiments in the treating of these lands chemically, or by leaching might be of interest, but would scarcely be within the scope of this paper. It is mentioned to show that the engineer must knew more than engineering. To master any one science requires a knowledge and familiarity with other sciences.

The third project now covers 10 acres. The initial construction was finished and the gate opened December 9, 1927, to the flood of the next rain.

At the highest corner of this field a large creek broke over its banks and washed a gully which after several years widened to about fifty feet. Later another break occurred higher up stream on the same creek. The water from this break scoured a wide channel and connected with the first channel. The swift water from the two breaks ruined a fertile field, washing some places a foot deep. Every spring the water carried away soil in many places to the depth of the plowed ground.

*Paper presented before a meeting of the Southern Section of the American Society of Agricultural Engineers, at Memphis, Tenn., February, 1928.

[1]President, Clover Fork Coal Co., Kitts, Ky. Mem. A.S.A.E.



Plan for culverts and spillways used on the ten-acre silt control project carried out by A. F. Whitfield in Kentucky

First, a dam was built around the break. Terraces were constructed, each one beginning on the edge of the field at one foot less elevation than the preceding terrace, except the fourth terrace is two feet lower than the third.

The terraces were laid off in such a way that when the spaces between are filled, the contour of the land will be as nearly as possible the same as before the erosion took place.

Wooden spillways and culverts were constructed through these terraces and an 18-in. clay pipe—cross-section 1.76 sq. ft.—was used to let the creek flow in when high water comes.

A rise of about 1½ ft. will start the water running into the field. When the top of the water is below that level, it was thought the water would be clear. When above that level, it was thought that the bulk of the sand would go by on the bottom and mud with enough sand would go through the pipe.

As the place for the opening in the first terrace is so near the inlet pipe of the protecting dam, and the difference in elevation so slight, an opening was made with no spillway or culvert. The second terrace has a culvert, the cross-section of which is 1.25 sq. ft. This culvert can be choked as desired. Above this culvert is the spillway. The third and fourth terraces have culverts 6x6 in. The culverts are choked to 3x3 in.—just enough to allow the water to run out and not render the land soggy.

Before a crop is planted the pipe in the protecting dam will be closed so that no water can flow from the creek into the field, and the choking will be removed from the culverts in the terraces to allow rain water to flow freely from the field.

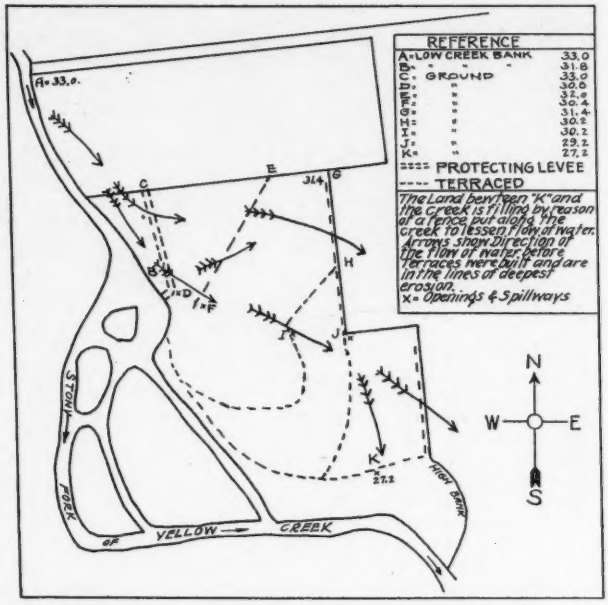
The spillway consists of two plank walls to hold the ends of the terrace 14 ft. apart, a plank set on edge extends from wall to wall and is well banked with mud on the upper side. The planks are set to raise the water 1 ft. high. The water spills over the plank to a floor to keep from washing the ground around the spillway. This floor will be covered with iron roofing from an old roof and the spillways will be made higher as the terraces become stronger and higher. The terraces will be made higher after each crop is gathered.

On taking levels and laying off this project, it was found that to perfect the scheme as desired, it would be necessary to take all the water from the upper break of the creek. Water from this upper inlet could be put on the land a foot deeper than water taken from the lower inlet.

This upper inlet was on a narrow strip of land belonging to another man and lying between the main body of the farm and the land to be improved. About two-thirds of it can be flooded.

This land, 6 acres, has been bought, thus connecting the two tracts and giving more territory for the silt-catching area.

To get complete results, the 10 acres must be drained. It is not considered wet land, but tiling would greatly increase the yield. It had 5 tons of ground limestone per acre applied to it two years ago, but the land had become so badly washed that it was unfit to cultivate. The yield was below 25 bu. of corn per acre and no crop was made the season before it was terraced.



Map showing the area in the ten-acre silt control project described in the accompanying paper by Mr. Whitfield

The work on the 10 acres was done by a teamster who was not an expert with a scraper and cost probably 50 per cent more than it should. The cost of the work was $143. Bills for material not received.

Will it pay? A man with long experience cultivating river bottom land, who looked over one of the small tracts, said, "The mud you are catching every year on that land adds more fertility than twenty loads of good stable manure per acre, and few farms are so situated that two hundred loads could be bought and scattered over 20 acres for less than $3 per load."

Almost every farmer has some land that can be treated in this same manner. The work can be done by him as fast as he can spare the time or money to do it. He will find lands thus improved are his best acres.

A soil with a few inches of silt mixed with it is the cheapest and best nitrate factory in the world.

Methods of Delivery of Irrigation Water

PRACTICAL experience in the delivery of irrigation water is the best guide to management policies of irrigation operation, says Wells A. Hutchins, irrigation economist of the Bureau of Public Roads, whose pamphlet on "Delivery of Irrigation Water" has just been published by the United States Department of Agriculture, as Technical Bulletin 47-T.

"The field of irrigation management during the present century has broadened more and more as numerous enterprises have been brought from the construction to the operation stage. Under the most favorable conditions, irrigation management, involved so largely with human relations, is a perplexing matter calling for a certain type of personality to handle it successfully," says Mr. Hutchins, "but many of the manager's troubles can be avoided if he is able to give general satisfaction in distributing water. The type of canal construction in many cases determines the method of delivering water and prevents the use of other and perhaps better methods without making expensive changes. In designing an irrigation system, therefore, it is important that the method of delivery best suited to local conditions be taken into consideration."

Three methods of delivery, depending on the time of service and the adequacy of the water supply, are continuous, rotation and demand delivery. Responsibility for control should not be divided, and control by the central management is usually preferable to local control by groups of irrigators. Maintenance may be either by local users of water or by men hired by the central organization, as far as labor is concerned, but responsibility and supervision should, as a rule, be centralized.

These and other principles are laid down and elaborated as the result of study and analysis of ways and means which have proved satisfactory and others which have proved unsatisfactory in most of the principal irrigation regions of the United States.

Factors in the Design and Operation of Dairy Machinery*

By A. Jensen[1]

AFTER a careful survey of dairy equipment design, with which I have had contact, I have come to the conclusion that the real successes, viewed from the broadest angle, are the things created from a balanced understanding of the underlying principles that govern design—which to me also includes invention—and that successful designing is the deliberate outgrowth of cool-headed thought expressed in ability, sacrifice and understanding, and backed by a reasonable amount of physical trial.

All new inventions and designs to succeed must be an improvement of what has gone before. In other words, designing is a specialty the same as other organized effort. The old saying of a chain being no stronger than its weakest link applies to all kinds of dairy equipment. By this I mean that new equipment will stand or fall on its commercial performance. I will mention here some of the factors that should govern the design and operation of dairy equipment:

1. The designer should have commercial plant training, with a thorough knowledge of physical, technical and sanitary engineering.

2. He must be endowed with the ability to study comparative efficiency, in its application to the laws of economics, and, if proven experience can be added to the requirements factors, it represents an added advantage.

In many years of contact with dairy manufacturing problems I have enjoyed the privilege of an extensive study of equipment design and its operation from most all requirement angles. I have seen costly efforts wasted in marketing equipment that could have been avoided if the requirements set forth had been considered, and it is not alone the manufacturers of improperly balanced equipment who lose, but the public loses as well.

You perhaps have knowledge of plants where the operator and owner following purchase have been compelled to absorb economic losses on unbalanced equipment, and that the direct and indirect damage done following actual use was greater than the benefit claimed.

Out of the millions of inventions on record throughout the world, only a very small percentage ever attains commercial recognition. Such a situation is, economically speaking, unsound, but there is a reason for this low percentage. A partial answer will be found in the previous reference to "weak links," and this again brings us back to the factors that should govern design, etc.

One inventor may excel in one particular thing and fail in all the rest; another may excel in all but one thing and fail because of one major deficiency. Other inventors fail because they develop a narrow viewpoint, while lacking in a fundamental knowledge of inventive procedure, often developing into suspicion, jealousy, distrust, etc. I have personally met a number of so-called inventors with unbalanced minds, where invention was concerned. Again there are individuals who have been privileged to share in the confidence of bona fide inventors and designers who will, at the first opportunity, unfairly undertake to capitalize the knowledge gained in confidence by claiming to be the original inventors themselves, etc.

It has been my observation that this last type of inventor, including the resulting inventions, never succeeds, for the reason that balanced design and honest effort go hand in hand. Then again we find hard-working inventors with the best of intentions and ability working with problems on which they lack basic knowledge; the resulting equipment invariably results in wasted effort.

Many inventors and designers, lacking one or more of the fundamental requirements, would have a better chance of succeeding if they would employ or consult other specialists, to assist them in the perfection of their ideas. There is really very little risk in employing someone else as long as the originator keeps proper record of what he is doing and is complying with the laws governing inventions.

Being primarily a commercial operator of dairy plants and understanding their economical side, my views on equipment design have always been from the angle of the operator, the inventor's side being incidental. I attribute a large part of the progress made as a plant operator, in some of the most highly competitive sections of California, to the following factors:

1. A thorough understanding of the commercial production of dairy products.

2. My ability to select and put into use improved equipment which is due to my early engineering training.

3. My ability in securing associates that greatly excelled my own training in several of the requirement factors.

4. A firm conviction that by staying with a theory once proven and never compromising on it, I would eventually solve in a better way the problem at hand. This applies to the product manufactured as well as the improvement incorporated in equipment design.

During the major portion of the time I was employed as an operator of dairy plants, the sole incentive that prompted me to undertake improved equipment design was the belief that I could produce a better product at less cost. In other words, necessity was "the mother of invention."

During those thirty years I can recall many distinct changes in equipment design and usage, several of which ran counter to the fundamental facts upon which the success of my dairy manufacturing business was founded. Some of the high lights of these changes I will mention for it not only has had a bearing on the development of the dairy industry as a whole, but it also is reflected in the general efforts put forth by designers and inventors of equipment:

1. Sweet cream butter vs. starter butter
2. Pasteurizing efficiency and temperature control
3. High temperature vs. low temperature pasteurization
4. Effect of surface application on dairy products

*An address before a meeting sponsored by the Committee on Dairy Equipment of the Power and Machinery Division of the American Society of Agricultural Engineers, held during the Pacific Slope Dairy Show, at Oakland, Calif., November, 1927.

[1]Consulting dairy engineer, Los Angeles, Calif.

The ice cream freezer is one of the most important applications of mechanical and engineering principles to the dairy industry. This picture shows the freezer installed in the dairy manufacturing laboratory of the dairy department of the University of California at University Farm, Davis

5. Body effect, following different methods of pasteurization
6. Effect of oxygen on flavors and keeping qualities of dairy products
7. Coil surface, drum surface, tubular surface vs. shell for heating and cooling
8. The effect of different metals and coated surfaces on flavors of dairy products
9. Cause of spotting and the corrosion of equipment
10. Brine—its effect on different forms of equipment
11. Stationary surface vs. movable surface in heating and cooling
12. Cause of the cream plug in market milk and cream
13. Cause of metallic oxidized flavors in dairy products.
14. Equipment and bacteria count
15. Cause of the separation or whey ing off of cultured milk
16. Vacuum application to dairy products and its limits
17. Neutralizing of acid cream
18. Sterile containers and their relation to quality product
19. Public health and dairy hygiene.

These and many other basic questions should serve as governing factors for the designer and manufacturer of dairy equipment.

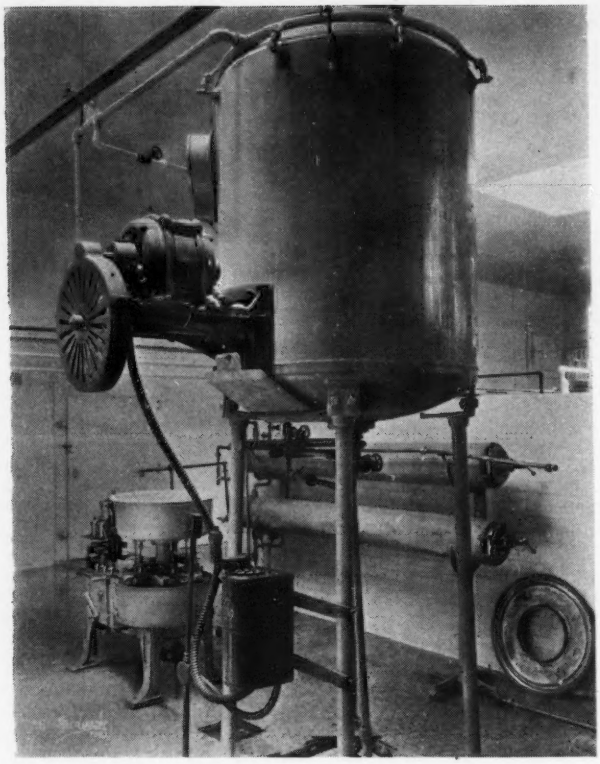
Now you will ask what are the forces that create these changes, which afterwards proved unsound? My answer is, Unsound promotion but efficient salesmanship.

And you will ask again, How is it possible to create unsound promotion of equipment of faulty design, especially on an extensive scale? My answer will be that corporations or associations do not differ materially from partnerships and individuals, for after all they are made up of individuals, and human fallacy and greed lack understanding some times.

I have also observed that the different groups of dairy product manufacturers have not in the past acted in unison in these changes. I recall where the market milk men have taken on new, untried equipment, with the ice cream men following more than a year later; the condensing industry not having the same problems would only partly follow. The manufacturers of butter, not being so well organized, have been known to adopt an idea at a time when the market milk men had totally repudiated it as unsound and wasteful.

In designing equipment for commercial dairy plant use, the engineer and inventor can profit by adopting the process of elimination in making his final decision. I know this to be the hardest task of all, for it devolves upon the designer to sit as an impartial judge over his own court, with his own effort on trial. Nevertheless, this method will contribute more constructive results than any other procedure I know of, barring impartial advice from other minds.

I recall a simple device that I wanted to perfect as a part of one of my designing efforts. The phases concerning me most of all were those of simplicity, durability, sanitation, and low production cost. My records show that I did spasmodic work on this one idea for more than a year, involving some fifty-four different designs and set-ups. When the time came for a final decision I assembled all of the sketches and notations and proceeded with the process of elimination to select the best idea. I got down to five different designs in a comparatively short time; the final selection resulted in a compromise by borrowing a point or two from one, a point



A motor-driven milk pasteurizer such as is used in the modern milk establishment

from another and so on until I was satisfied that I had selected the best ideas. The finished device has since measured up to all that was hoped for it, including acceptance by the public.

I am a firm believer in making a record of all ideas in any group design that I am interested in, as I find it to be of much help in deciding on the final design; it also serves as a basis for establishing legal claims where inventions are concerned.

Machinery or equipment correctly designed and built may utterly fail to perform in the hands of careless, indifferent operators, so here again we must face and solve the same factors that govern design. Sometimes the manufacturer is to blame for the failure of his product to perform, by his indifference to sell his complete thought to the plant operator due entirely to lack of understandable operating instructions.

Then again the manufacturer often overlooks the need of maintaining contact with the user through a follow-up service. This single feature alone deserves more serious consideration than anything else, as a close follow-up may mean the further perfection of good ideas, while also creating goodwill among the users.

Corn Borer Equipment Ready for Service

EQUIPMENT purchased by the U. S. Department of Agriculture for use in last season's intensive campaign to control the European corn borer has been completely conditioned. Engineers estimate that the depreciation has been less than ten per cent. Approximately 2,800 units of machinery were stored in the sheds of the army ordinance depot at Erie Proving Ground, near Oak Harbor, Ohio, last fall. A force of mechanics immediately went to work overhauling the machinery and making repairs to put the machinery in working order for use this season. Smaller quantities of machinery have been stored under cover at Toledo and Elyria, Ohio, where repair service has also been provided.

In addition to overhauling, the cylinders of the tractors were filled with oil, plows were greased, and trucks with pneumatic tires were jacked up. More recently D. A. Milligan, who superintended the work, and his staff have been reconditioning the heavy trucks which failed to stand up under field conditions last season.

Fewer than forty men have done the work and the cost has been less than one per cent of the original cost, except in the case of stubble beaters. On these machines the low original cost and the necessity for new blades made the percentage cost of overhauling somewhat higher. In doing the work the Department of Agriculture benefited from the full cooperation of the War Department which furnished the storage space and opened the facilities of the ordnance depot and machine shop at Erie Proving Ground for use by the repair crew.

What Electric Service Means to the Farmer*

By G. C. Neff[1]

WHILE there are many things that have contributed to the prosperity and high standard of living in this country, the liberal use of power and machinery in industry is a big factor and is largely responsible for the high average wage paid labor.

The farmer is in competition with industry in the employment of labor. If industry pays labor a high wage, the unit cost of labor on the farm must be high. The highest single item of cost in operating a farm is the cost of the human energy required, so that while it is a wonderful thing for this country to have a high average level of wages, it proves a hardship to the farmer unless he can use labor as efficiently as general industry.

The American farmer has made great progress in the use of machinery and labor-saving devices, but the development in this direction has not been as rapid as in industry. The result is that at the present time the farmer is not in position to use labor as efficiently and, therefore, the farming business will not support as high a wage to labor as general industry. This is borne out by a survey made by the U. S. Department of Agriculture and reported in the July 1925 issue of "Crops and Markets." This survey shows the total gross income of American farmers for the year 1925 to have been approximately twelve billion dollars. This figure includes the value of farm food products grown and consumed on the farms. A 1924 report of the Department shows there are approximately thirty billion man-hours of human energy used annually on the farms of the United States. If the entire gross income of the farms of the United States were used to pay for the thirty billion man-hours, the hourly wage would be 40 cents. From these earnings the farmers must support their families; must pay all farm operating expenses; must pay taxes on property valued at approximately sixty billion dollars, and must pay interest on this huge amount of money.

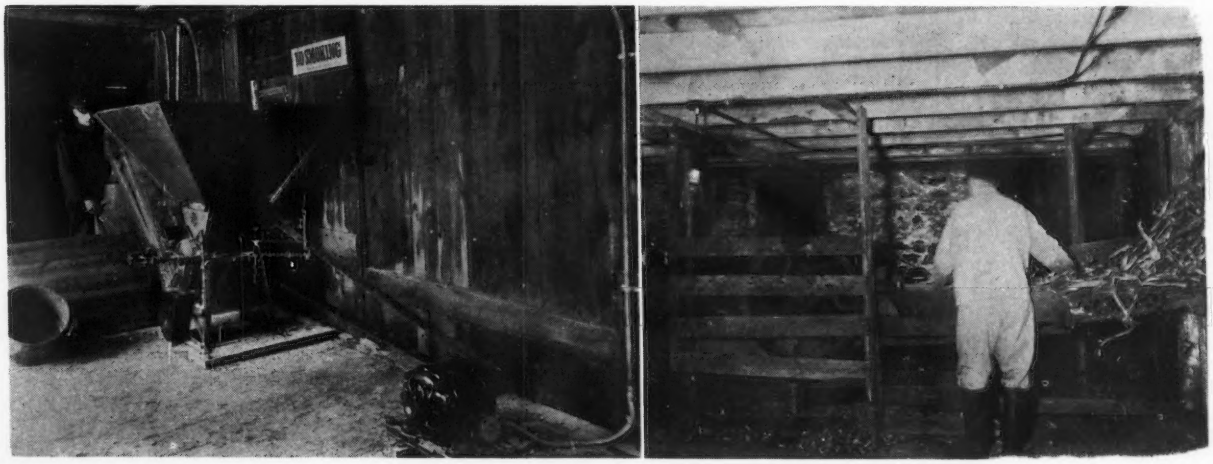
While there may be many things that can be done to bring prosperity to the farms of this county, one thing is essential, namely, that farming methods be brought up to a standard whereby machinery and labor-saving devices are used in the same degree as used in industry. Machinery and power will increase the income per worker on the farm in the same way it has increased the income per worker in the factory. Take central station electric service away from the industrial life of this country and the wages paid to industrial workers will drop, because the application of central station power to industrial operations has greatly improved old methods. It has brought about lower production costs and has increased the amount and quality of goods produced. Central station service brought to the farmers and properly applied will do as much for the operation of the farms. It is, therefore, very important that we who are giving serious thought and study to rural electrification recognize that in addition to the many conveniences and comforts that central station service will bring to the farmers it will also improve the methods of production, increase the profits, and make farming a better business.

This situation is being recognized by the public as measured by the editorial attention which rural electrification is receiving. All classes of news mediums are giving attention to the subject in some form or other. This ranges from features in Sunday supplements to rather extended discussions of editorial columns. The farm press, metropolitan dailies, technical publications, magazines, and weekly newspapers have clearly indicated their appreciation of rural electrification as a subject of news value. Almost without exception the comment has been favorable to the plan of development now being actively backed by the light and power industry, the agricultural industry, and others who are interested. While we have every reason to be gratified over this situation, we cannot with impunity disregard the significance of this interest of the public press. Indeed, the general public is rapidly coming to look upon rural electrification as desirable, not only for agriculture, but also for the nation as a whole. It, therefore, behooves each one interested in rural electrification to see to it that they do their part to foster developments in this field in an efficient and energetic manner.

It was only about three years ago that the electrical and agricultural industries began a joint study of rural electrification on a national basis. It is gratifying to report that during this three-year period the number of farms served by electric light and power companies increased over 86 per cent bringing the total farms so served to more than one-third of a million. Considering that the three years just past have been years of agricultural depression this represents a re-

*An address before the Rural Electric Division at the 21st annual meeting of the American Society of Agricultural Engineers, at University Farm, St. Paul, Minn., June, 1927.

[1]General manager, Wisconsin Power and Light Co., Madison, Wis. Mem. A.S.A.E.



Scarcely more than a beginning has yet been made in the efficient application of electric power to farm operations. In these pictures are shown a 1½-hp. electric motor used to drive a feed grinder and a hay cutter

markable development. If this increase continues at the same rate, there will be approximately one million farms receiving central station service in this country by the end of 1932. It can, therefore, be said that rural electrification, which formerly has been looked upon largely as an investigational project has now definitely emerged into a distinct and important part of the electric light and power business, and because of this fact the electric light and power industry is rapidly becoming an important factor in agricultural development. The successful development of rural electrification is dependent upon the part played by those in the electrical and agricultural industries.

Due to the fact that electric service extended to the farm is a new class of utility business and is a new application of light, heat, and power service to a new class of customers scattered over wide areas, the problems involved are quite different from those connected with city service. If, therefore, seems necessary that in order to handle this new development efficiently and satisfactorily, each power and light company should create a separate rural service department to devote its entire energies to the proper handling and solving of all rural electric service problems and should be made responsible for the direction of the development. Many public utility executives have seen the need of and have created rural departments in their organizations, and are giving such departments full cooperation and backing which is so necessary for their success. In 1925 approximately nineteen utility companies in the country had organized separate rural service departments. In 1926 approximately sixty companies had organized such departments and forty others had rural service specialists devoting their entire time to this new work. It is, therefore, very evident that many public utility companies in this country are becoming very active in promoting extension of service to the farm and are building their organizations so this important development will have intelligent guidance and direction.

A properly organized rural service department in the organization of any electric light and power company will develop a schedule of rates and extension rules which will fit the rural conditions of the territory to be supplied. The rate should be simple and easily understood. It should be so designed that it will encourage increased use of electric service by the farmers. It must give proper return to the utility for the service rendered. Serious consideration should be given to the financing of distribution lines by the utility companies. While this will of necessity somewhat increase the monthly charge for service, it will permit the farmer to buy more utilization equipment than he would buy if he had to use his money to finance the building of the rural distribution lines. Almost without exception those companies who have organized separate rural service departments are taking the lead in extending service to the farmers in their respective territories.

Anyone who has given much serious thought and attention to the subject of rural electrification knows that, if electric service is to be supplied to the farmers at a price the farmer can afford to pay, a substantial electrical agricultural load must be developed.

Those who are primarily interested in agricultural development have a heavy responsibility resting on their shoulders to see that this agricultural load is developed along the right lines. It is evident that electric lines are now being rapidly extended into the country, that farmers are actually receiving service from these lines in ever-increasing numbers, and you agricultural engineers should be very much concerned in seeing that the farmers do not spend a lot of money for utilization equipment that they should not buy or do not make use of the service in an inefficient manner. You are also vitally interested in having the farmers use the electric service for every purpose which will be of benefit to them.

At the present time, the farmer knows very little about how and where to use electric service, and he is looking to the men in the agricultural colleges and experiment stations to guide him. You have an opportunity and an obligation to see that all information regarding the proper use of electric service on the farm is made available to the farmers themselves. The agricultural extension departments of the agricultural colleges can do very constructive and valuable work if they, through the county agents and otherwise, will see that as soon as any efficient use of electric service on the farm has been tested and proven to their satisfaction, that full information regarding that use should be gotten to the farmers as quickly as possible. This will make the service of most value to the farmers and will at the same time protect them against making unwise investments in inefficient equipment.

Rural electric development is coming so fast that electric light and power companies and the farmers themselves will be requesting more and more information from you regarding the proper and most efficient use of electric service on the farm. Because of this fact it seems to me that it is desirable from a national standpoint for the project leaders to correlate the investigation work so as to reduce duplication to a minimum and insure the various aspects of the subject being well covered.

Purdue University and the Oregon Agricultural College plan to give rural electrification short-courses for electric light and power men this coming winter. It may be that other agricultural colleges will also give such courses. It would also seem desirable to give a course in rural electrification to the farm boys who come to school to take the short-course.

There is much to be done to fully inform the farmers and the electric light and power people regarding how to properly use electric service on the farm, and the responsibility of this rests largely with the agricultural engineer. While much has been accomplished to date, it is only through continued close cooperation by the men representing the agricultural and electrical industries that rural electrification will be made a fact quickly and in an efficient manner.

Four-Day Farm Machinery Study

Lacking space in his own department for laboratory work in farm machinery, R. U. Blasingame, professor of farm machinery, Pennsylvania State College, borrowed some space, brought in some representative types of implements and equipment, and conducted an intensive four-day laboratory study of this material. The forty students in the farm engineering course were excused from all other classes during these four days. Approximately three hundred students and faculty and one hundred local farmers attended a general meeting called the evening of March 13, just previous to the four-day session. Speaking to this group, Dean R. L. Watts pointed out the favorable position which the American farmer enjoys, compared to farmers in some other parts of the world, as a result of his greater use of machinery. Arnold P. Yerkes, of the International Harvester Company, emphasized the fact that farmers of some other countries are progressing as rapidly as those in America in the matter of using labor-saving equipment.

Some Mole Drainage Experiments in Michigan*

By O. E. Robey[1]

MICHIGAN has approximately 5,000,000 acres of land requiring drainage. The most valuable land of this area is clay, a good share of which is under cultivation. While a great deal of tile drainage has been done in the state, it received a great setback when the slump came after the war.

It is difficult and perhaps economically unsound to advocate a $40 an acre investment in tile drainage when the farm may be mortgaged for more than its present value, and yet some relief should be offered to protect the farmer against losses from seasonal periods of wet weather.

With the hope of finding a cheaper way of meeting the drainage situation under the present economic conditions, a study was made of mole drainage. All the available literature of this country and Europe was read to determine if this method of drainage had any merit.

The study of this literature revealed that mole drainage is by no means a new practice. It dates back at least to the beginning of the last century. In fact, in England on December 9, 1795, a Mr. Weston wrote as follows: "With respect to the mole plow, I really think too much cannot be said in its commendation for the purpose of temporary drainage. From ten to twenty acres can be drained in a day by a single team."

About 1855 we find references to a Major Dickinson, of New York, having used this type of drainage, and apparently it had been in use for some time on his farm as a writer in the New York "Tribune" states, "From ten to twenty acres per day are thus drained, and Major Dickinson has such drains of fifteen to twenty years standing, which still do good service."

At later periods this method of drainage was used in Illinois, Iowa and other western states, and finally in California.

Mole drainage seems to have had waves of popularity owing to the fact that it met an emergency, and then was abandoned because it lacked universal application and durability. During all this time, little improvement has been made in the machinery for constructing mole drains. The original mole plow patented by Mr. Scott in 1797 consisted of a plow beam and handles fitted with a long coulter, on the bottom of which was attached a wedge-shaped knife. When this plow passed through the ground, the bottom of the coulter formed an opening 18 to 20 in. below the surface through which soil water could drain to a lower point. This tool, of course, is practical only in a clay soil. These early plows were drawn by several teams of horses or oxen, or by a windlass and cable.

Quite recently a revival of interest in mole drainage has taken place in England. During the World War, the British government mole-drained a large amount of farm land in England in order to increase its production. Recently I had a talk with a British army officer who spent most of his time while in the army supervising mole drainage and he was very enthusiastic about it. Since the war, the British Ministry of Agriculture has been carrying on demonstrations to further introduce mole drainage. Judging from reports appearing in British agricultural papers these demonstrations have been very successful.

This array of historical facts indicates that mole drainage must have some virtue, and with the use of modern power equipment might be made more practical.

In order to gain some first-hand information, a mole plow was purchased by our department, and some plots of 10 to 30 acres each were put in in different parts of the state.

This plow is designed to put in drains 2 ft. deep. It is equipped with a 3½, 4½ and 6-in. mole. After experimenting with the different sized moles, it was decided that the 6-in. mole was the most satisfactory, since it compressed the ground more and the large hole would be less liable to fill up. The plow was hauled in most cases by a 10-ton track-type tractor. Tractive pulls of from 6000 to 9000 lb. were required.

The ideal condition for doing the work is when the ground is moist below and dry enough on top to give good traction. The clay must really be wet enough to puddle. Under this condition, the mole leaves a smooth and sort of case-hardened surface on the inside of the hole.

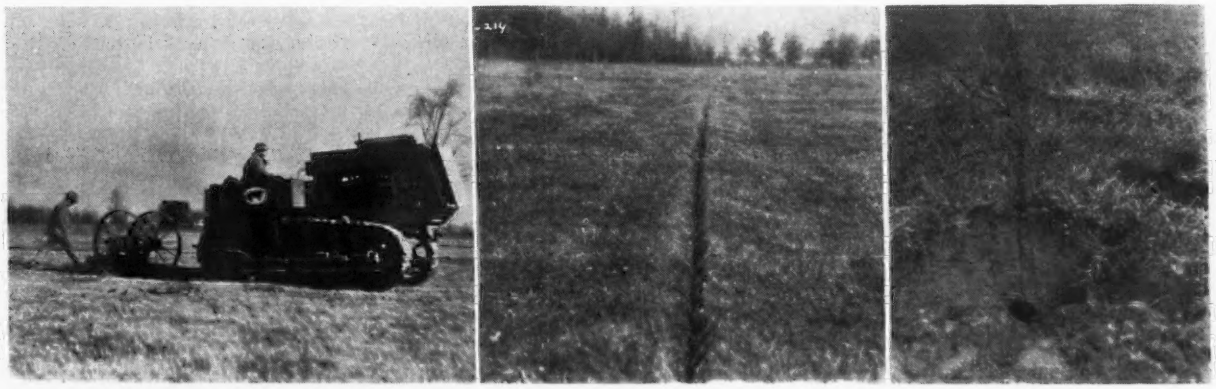
When we first began the study of mole drainage, we believed it suitable only for a very even heavy clay soil with a slight fall. But we have found that it readily adapts itself to fields with irregular topography.

In combination with tile on these irregular fields, it can be used to cheapen the cost of drainage. Tile can be laid following the contours through the lower parts of the fields, and the moles can be arranged in parallel lines at regular intervals and bring the water to the tile where they cross.

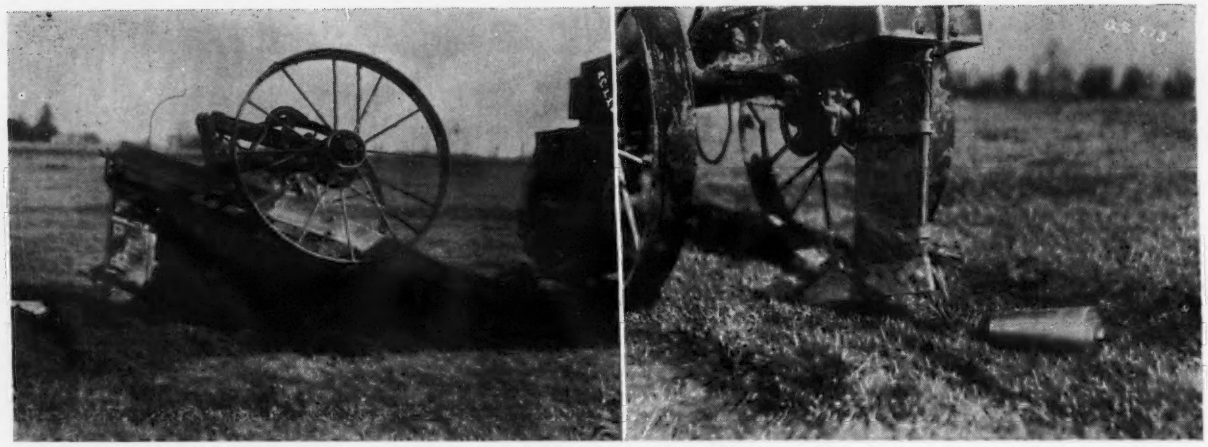
A great deal of our soil is of the boulder clay type, and we wondered how this machine would work when stones were present. While this type of drainage is not adapted to stony ground, we found that an occasional stone did not seriously interfere. We hit stones varying from a few inches in diameter to nearly four feet square. For large stones, we found the machine a perfect lifter. Of course, where a large stone was removed, it was necessary to dig down

*Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, November, 1927.

[1]Department of agricultural engineering, Michigan State College.



(Left) Ten-ton Caterpillar tractor pulling mole drainage unit equipped with six-inch mole. (Center) Not the result of an earthquake, but the fissure in the ground made by a mole plow. (Right) Cross-section of land mole drained to show the hole made by the mole



(Left) For large stones the mole plow proved a perfect lifter. (Right) Rear view of mole plow, showing "mole" lying on the ground

and put in a few tile when the mole line was broken.

Every field is a problem in itself. Where there is an open ditch at one end of the field into which the moles are to empty, we found considerable time could be saved by running three or four moles into one short tile outlet at the ditch. This saved going across the field empty. The machine can be backed practically into the ditch.

Various schemes have been used for connecting moles together and also connecting to tile lines. The connections have not been in long enough to determine their relative value. Some connections were made to tile lines by simply passing the moles crosswise and a few inches above the tile. The moles simply bring the water to the tile so that it can seep through the few inches of soil into the tile. This method makes it possible to remole the field without disturbing the tile. In some cases a Y-branch was placed in the tile line and two or three tile forced into the mole. This was only used on very level land where there would be little danger from washing. Stone and gravel were also used at the junctions of the moles and tile lines to facilitate the water getting into the tiles. Where a junction was made between two mole lines, a small hole was dug at the junction and three or four tile used to make the connection the same as in tile drainage.

One of the troubles experienced with the machine used is clogging. The machine works quite satisfactorily on soil that is free from rubbish such as plowed ground or a timothy or fine grass sod. This machine was tried on an alfalfa sod and would not cut the roots. The roots would accumulate under the machine and lift it out of the ground.

It is planned to attach a rolling coulter ahead of the rigid coulter to cut the roots. If the frame of the machine did not ride so close to the ground, it would be easier to attach a coulter and would prevent rubbish from accumulating.

Aside from the machine being designed so as to overcome the troubles previously mentioned, other desirable features would be to have some means of controlling depth as the machine moves along. The drains are usually put in parallel with the surface of the ground, depending on the general slope for the necessary fall. Yet very often there are slight variations which cause lumps or pockets in the mole line. Most machines are provided with an adjustment for depth, but it is not easily handled when the machine is moving, and there is no sighting device to determine when the machine is running true to grade. On tractor-drawn machines a sighting device is not so easily installed owing to the fact that the tractor obstructs the line of sight.

Mole drainage is not generally thought of as a permanent method of drainage. Its great advantage is its cheapness. On the soil where it is adapted, it serves two purposes, that is, draining and subsoiling at the same time. Assuming that mole drains will only last three or four years, if, when repeated, the lines are put in a different place, the soil will eventually be thoroughly subsoiled.

Mole drains can often be used on land where the depth of the outlet does not permit of satisfactory tiling being done. By placing shallow mole drains close together the same results can be obtained as with wider and deeper tiling.

The practicability of this type of drainage is dependent on two things: (1) Its durability under the soil, topographical and climatic conditions and (2) availability of suitable power.

Its durability can only be determined by tests. After reading all the literature available which gave experiences covering over one hundred years and reported instances of the drains operating successfully for periods ranging from one year to forty years, we decided that the best way to find out was to put in the test plots under various conditions. These plots have not been in long enough to secure any reliable data.

We have, however, a large farm in Michigan comprising several thousand acres which has used mole drains and open ditches exclusively. This farm is very level, being a reclaimed river bed and the soil is a fine silt. Each forty acres is surrounded by an open ditch. The land is mole drained into these open ditches. Some of the mole drains have been in ten to twelve years.

Large tractors of the track type are not generally available at least in Michigan for doing this work. In our state tractors of this type are owned largely by counties and are used for road work, and the counties are not interested in private jobs. From our experiences so far it would seem that the season in which mole drainage can be done is very short, and it will not pay to buy expensive tractors to do this work exclusively. If the tractors can be used for other jobs during the rest of the year, then, of course, it would be more practical.

There is need of further investigation in the use of tractor-operated hoists for hauling the mole plow. In order to use tractor hoists satisfactorily, a quick and easy method of anchoring must be devised.

A few small plots are hardly adequate to determine costs accurately. A contractor putting in mole drains would have a lot of delays and other expenses which would run up the overhead, but from time records taken we believe that the drains could be put in at a very low figure.

Our experience indicates it is possible in large fields to mole drain thirty to forty acres per day two rods apart. Assuming an operating expense of $40 per day, this would be but slightly over one dollar per acre.

The experimental work in mole drainage planned by the agricultural engineering department at Michigan State College has for its objects:

1. The installation of test plots
2. A study of various methods of applying power
3. Developing a leveling device
4. A study of methods for reducing the draft

5. The possibilities of the power take-off in the operation of the mole drainer

In laying out the test plots, we had in mind not only the testing of the durability of mole drainage, but we have arranged under various soil and climatic conditions drains at various spacings from one rod to four rods and with various size moles. The mole lines have been put in parallel with tile lines and arrangements have been made with the soils department to run tests on various crops on undrained, mole drained, and tile drained strips in order to determine the relative values.

Some experiments have been made with the use of a small tractor and hoist to pull the plow. It is planned to continue these experiments. We have been sufficiently encouraged by these experiments to believe that this may be a possible solution of the power problem.

Some work has also been done in developing a leveling device.

In an attempt to reduce the power required, a study was made of some English experiments in which they used electricity to attract water to the mole in order to reduce friction. We have been trying to do the same thing by injecting water around the mole. Also a mole has been chromium plated and tests have been made to determine whether the additional smoothness will materially reduce the draft.

None of these experiments have, as yet, been carried far enough to furnish us with reliable data. We hope by another year to have something upon which we can base some conclusions.

It is realized that this paper is largely one of methods rather than results. Maybe our results will cool our enthusiasm; yet we feel from the work already done that while mole drainage is an old, old practice which several times has been abandoned, we cannot help but believe that in combination with our modern power machinery it may be due for another revival, not to supplant but to supplement other types of drainage.

Improved Methods Reduce Tractor Operating Costs*

By James Mills, Jr.[1]

DURING the past twelve years successful farming has presented many management problems to farm owners. In horticulture particularly we have been passing very rapidly from the horse to the tractor age.

The first orchard tractors were inefficient, expensive to maintain and operate and were unable to compete on a cost basis with horses; but labor conditions were such that each succeeding year they were worked into the farming schedule as a means of minimizing the labor problem.

Each year has seen very rapid advances, not only in tractor, but in tractor tool construction, until today we find ourselves in possession of equipment with which the horse can in no way compete. During the transition period we have found it most difficult to set up a reliable basis for depreciation of tractor tools, as the depreciation reserve set up has of necessity been one for obsolesence more than for actual depreciation. We have finally decided that the best method to employ to properly picture this matter in our operating costs is a yearly valuation of all tools based on their actual operating value. With tractors, a yearly depreciation of 20 per cent has been found to be entirely adequate to cover both actual depreciation and obsolesence. The latter item during the last five years has not been a big factor. Our four-year-old machines today are operating almost as cheaply as the new ones.

In the large scale operation of tractors, experience has shown it most advisable to maintain an up-to-date shop with an efficient shop foreman. It is the shop foreman's duty to supervise the maintenance of the tractors in the field and we have found this easier to accomplish by having the foreman in the field during the "swamping-up period" each evening after the day's work is done. At that time he checks up on the greasing, all adjustments and decides whether any actual shop work is necessary.

When a tractor comes into the shop, the driver of any particular machine takes a secondary position and his wages are dropped from the regular operating scale of $4 or $5 to the shop helper's scale of $3.50 to $4. This is done to place a premium on the continual successful operation of any unit in the field, as it costs the operator as well as the company money whenever, through any faulty care, etc., it is necessary to bring the machine into the shop.

To properly allocate shop charges, a shop operating account has been set up. The mechanic's time is charged against the job at $1 an hour and his helper at 50 cents. These amounts are found to be sufficiently above their actual remuneration to pay for all miscellaneous shop charge, such as shop power, maintenance of tools, miscellaneous bolts, nuts, etc., which are difficult to charge directly to any one piece of machinery being overhauled.

To properly distribute the tractor work in the field, service recorder clocks are used. On the wax disks of these clocks, by means of a vibrating needle, is cut a path on the wax showing when the tractor is standing still, when the motor is running and when it is actually moving on the work. Only the actual operating hours are used as a means for distributing the tractor time against the job. A fixed charge per operating hour is used. This charge is moved back and forth from year to year so that tractor credits against any one machine practically balances the actual cost records kept on that unit. These recorder clocks, in addition to providing an actual distribution of operating time, show the foreman at a glance the efficiency with which any unit is being operated and point directly to any trouble in the field which needs investigating.

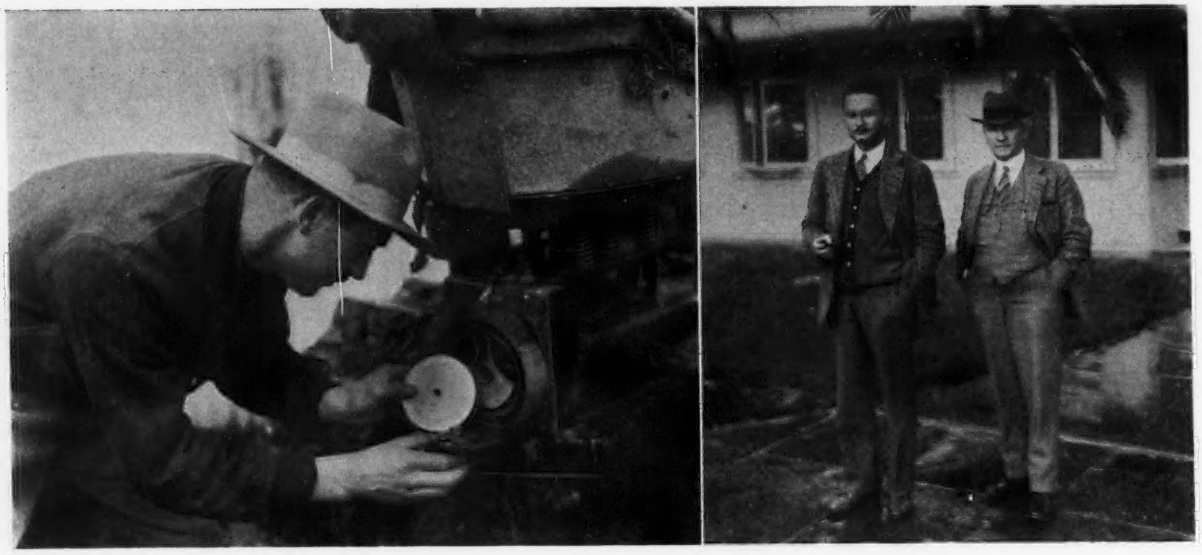
As mentioned before, during the past few years, a very great advance has been made in tractor equipment, and this advance is very well pictured in the following figures:

	Tractor Cultivation	Hours of Man Labor	Cultivation Cost, Total	Acres
		Prunes (Hamilton)		
1922	6661.22	992.49	$7653.71	355
1924	2885.49	1682.69	4578.18	355
1926	2413.34	155.35	2578.69	371
1927	2278.75	564.09	2842.84	371
		Lemons (Maxwell)		
1922	20201.05	6082.83	26343.88	713
1924	4650.80	4238.54		
	5256.25	2894.11		
	9907.05	7132.65	16039.70	713
1926	15166.64	3391.45	18557.07	
1927	11419.00	2551.53	13970.53	713

The costs as given do not include the maintenance or depreciation of tractor tools or the depreciation on the tractors themselves, but all actual maintenance and operating

*Paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at University Farm, Davis, Calif., January, 1928.

[1]Vice-president and ranch manager, J. Mills Orchard Corp., Hamilton, Calif. Mem. A.S.A.E.



(Left) Mr. Mills taking the record off one of the tractor service record clocks at the end of a day's run at the Mills' orchards. (Right) James Mills, Jr., and James Mills, Sr., ranch manager and presiden t respectively, of the J. Mills Orchard Corporation

costs on the tractors are included. The savings as shown are due, as mentioned above, to the continuous advance in both tractor and tractor tool equipment, as well as to the following:

1. A change in cultural methods which have been made possible by more efficient tractors and specially developed cultivation tools. Our cultural methods as now employed on our two properties consist in the cultivation of a large depth of soil infrequently, while formerly with lighter tools they consisted in the cultivation of a small depth of soil very frequently.
2. Improved methods of management, many of which have been mentioned above.
3. A very material decrease in the amount of hand labor necessary around the trees effected through the year of newly developed offset disk harrows which are especially adapted for close work under overhanging branches.

Experience has shown that the equipment necessary on our Maxwell Ranch, which is a sidehill property consisting of, in round numbers, 850 acres of orchard, to be three five-ton and one two-ton track-type tractors; and on our Hamilton property, consisting of 900 acres of orchard on level lands, two five-ton and two two-ton track-type tractors do the work.

During the spring rush, for a period of six weeks to two months, two additional tractors are rented at the Maxwell Ranch and one at Hamilton to rush through the work with all possible dispatch. On this rental work it has been found that, operating on the clock, our basis produced more economical results than any other yet tried.

Actual cost data of operating one of our tractor units taken at randon from our records, a total of 7,383.8 hr. operating time for show tractor No. 19, for the period May 1923 to and including July 1927, but not including September and October 1926. The total operating cost was $15,118.06, or $2.06 an hour. This is one of the more expensive rigs, as some of the tractors of the same size operate for as low as $1.60 an hour. These figures include all maintenance but do not include depreciation.

Northwest Farm Managers Association

CLOSELY paralleling the interests of the American Society of Agricultural Engineers, but working in a different way, the Northwest Farm Managers' Association is doing much to promote the application of engineering to agriculture.

Its members are all farmers, operating their own farms or managing farms for other owners. The area of land under the control of each of these men runs from one thousand to thirty thousand acres. Individual members are in some cases in charge of as many as thirty-five farms.

These men are not prejudiced in favor of or against agricultural engineering, or anything else, apparently. They are out to learn how to operate their farms, in every detail, according to the best known practices, and to give each other and also other farmers who may not be members, the benefit of their experiences. Show any one of them a better practice, for his conditions, than he is now following, and he will adopt it at the first opportunity.

With acreages sufficiently large to fully realize the possibilities of modern farm machinery, these progressive farmers use it extensively. Neither do they neglect the other phases of agricultural engineering.

The organization works along several lines, each very definite in plan and purpose. Every winter the members meet at the North Dakota College of Agriculture at Fargo, for a few days, to discuss their experiences and what they have learned during the year. Each summer they make an auto tour to the farms of some of their members to "see how the other fellow is doing it." One hundred or more auto loads of members and visitors are expected to make the tour this summer.

Information which the association has on any definite subject of general interest is published as an "Agricultural Service." Of the seventeen services issued so far, eight deal with distinctly agricultural engineering subject matter.

Much credit for the progress of the association since its organization in 1909 is due Prof. Cap E. Miller of North Dakota Agricultural College, who first realized its possibilities, and who, as its secretary, has been boosting it ever since. Among other things, he keeps the members in touch with each other throughout the year with a long, newsy, inspiring letter every month.

These men, engaged in agricultural production on a large scale, aware of the relative importance of every item in their costs, wide awake to every opportunity to lower those costs and to improve the quality of their products, call themselves "farm managers." We would call them "pioneer agricultural industrialists."

Solving the Labor Problem in Farming Operations*

By Roy E. Murphy[1]

I DO not have a sure cure for all farm labor problems, but I will undertake to tell you how I have handled it at Forestdale Farm.

I thought first of the comfort and contentment of my employees—that if their work was made pleasant and if we did away with as many of the objectionable chores about the farm as possible, they would be less liable to consider making a change. I dislike changing help very much. It spells inefficiency in the operation of any organization. So I began eliminating the objectionable features of our farming program.

After keeping very accurate records on milk production from the few cows we had, I went to a neighbor who specializes in dairying and had him quote me a price on the same amount of milk we were producing, delivered to my door each morning. It was about 65 per cent of my cost of production. Straightway I disposed of the cows, and with them went the chores that are distasteful to any farm hand that has general farming work to do.

Now do not think that I am giving dairying a slap in the face—far from it—but to my way of thinking it must be the major operation on the farm and not a side line, if it is to be pleasant and profitable.

The next and most important step in solving the farm labor problem at Forestdale was to dispose of all the horses and substitute mechanical power. This did not take place over night, and the decision was not arrived at without some rather warm discussions first at home and then with some of the faculty at Iowa State College. I was told that a "horseless farm" in the corn belt could never be more than a pipe dream.

Anyway I sold my last team early in 1924, and I can say, in a loud voice, that I have never regretted it for a minute. We do everything on this typical corn belt farm with our tractors, and the various attachments designed especially for them, that you could do using horse-drawn outfits, and some that you couldn't do with horses.

Let me say here that I believe the tractor will do more in the years to come than any other one thing in keeping young boys on the farm. That means keeping efficient workmen on the farm. If their work is made pleasant and profitable, they will not be champing at the bit to get to town and get a white collar job—where they probably receive twice as much per day and save nothing.

I want to point out some of the outstanding instances in our farming operations that save much labor and money also.

One that comes to my mind, that seems to show the efficiency of the tractor and the labor and money saved, is in the spring of 1924. I started with the tractor at 4:00 a.m., and by changing operators at meal time, worked right through to 6:00 p.m. In 14 hr. we plowed, at a depth of 8 in., 19 acres at a cost of $16.80. My neighbor using five head of horses and plowing 5 in. deep was 4½ days doing 20 acres, at an approximate cost of $80, at $8 per day for teams.

In cultivating the tractor is superior to the horse. With the small all-purpose tractors, we cultivate from 19 to 24 acres per day and cut the cost of operation down a great deal from that of horse-drawn cultivators. These cost figures on cultivating with two-row motor cultivator are given in an article in the November (1926) issue of "World's Work" taken from my records.

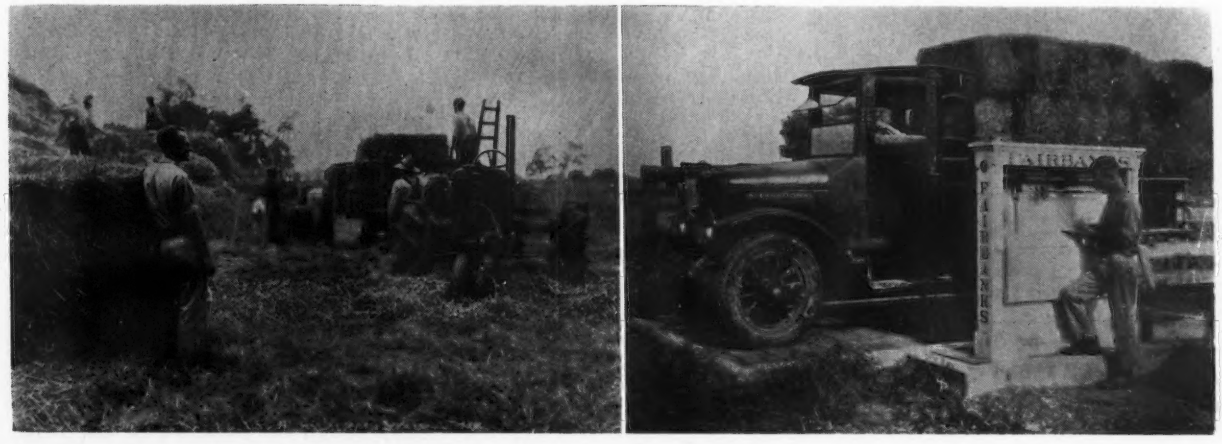
In hay making the tractor again lowers production cost by increasing the acres handled per man per day. With the all-purpose tractor, we cut a 7-ft. swath and rake it at once—and do it in a hurry, as this machine travels at a high rate of speed.

We have been rather severely criticised for our method of handling alfalfa, but "the proof of the pudding is in the eating," and when a professor from the extension department at Iowa State College was at our farm last winter, he took a sample of this alfalfa along with him and reported it the best sample of Dakota No. 12 he had found all winter.

During the summer months, when generally the days in the field are extra long, we are through at 6:00 p.m., except in very urgent cases, and when we drive the tractor and truck in the sheds and shut off the ignition, the chores are done; the "horses" are put away for the night; the men can go through their evening meal leisurely, have time to get cleaned up, go out to the neighbors, for a ride, or to the movies. They have time for some recreation, and a good night's sleep puts them in fine condition for the next day's

*An address before the 21st annual meeting of the American Society of Agricultural Engineers, at University Farm, St. Paul, Minn., June, 1927.

[1]Superintendent, Forestdale Farm, West Burlington, Iowa. Assoc. Mem. A.S.A.E.



(Left) In the foreground, Roy E. Murphy, manager, Forestdale Farm, watching the operation of straw baling. (Right) Mr. Murphy, here recording the weight of a load of baled straw, keeps detailed figures on all his farm operations. He is a typical example of the new "agricultural industrialist"

work. They come on the job in good spirits. The man that is using horses feels that he has to stay in the field until about 7:00 p.m. to accomplish a day's work. By the time his horses are taken care of and he gets to his supper, it is 8:00 p.m., and by the time he finishes his meal and gets cleaned up, it is time to go to bed, no time for a ride to cool off, no recreation. Believe it or not, our method has a value other than that computed in dollars and cents.

At grain harvest we certainly walk away from the horses. Last year we worked one day for fifteen straight hours and cut 64 acres of grain by changing operators at noon. This was done by using the general-purpose tractor on a ten-foot power binder, a storage battery and spot lights. Can you imagine how many horses it would have taken to have kept that binder going straight through like that with the thermometer registering about 101 deg. most of the time?

We thresh with a 15-30-hp. tractor for power, and use the general-purpose tractors for pulling bundle wagons and trucks for grain. We also do custom threshing in the neighborhood and, though I have increased the charge per bushel, I have lowered the threshing costs very much for my neighbors.

For corn harvest we use the larger tractor on the corn picker, and the smaller ones for pulling loaded wagons to the cribs. Instead of the boys dreading to see corn shucking time come, they look forward to it with interest, as they like to see how much they can beat the previous year's record for the number of acres per day.

By the use of the corn picker, we eliminate the labor of breaking, raking and burning the stalks, and have the stalks to turn under for fertilizer, which is worth about $12 per acre. Also the ground can be fall plowed in most years, but not the last two years. Here is one of the important points in money and labor saved by having a motor-equipped farm. The tractors were not eating a thing, while they were not working during the rainy falls of 1925 and 1926, and they also bring down the labor incident to choring, as they don't have to be fed on Sundays and holidays.

You probably will wonder with all this labor saving how we have enough work to keep busy. That is just the point I want to bring out. We have more time to give to feeding and caring for our livestock. We have increased our hog production about 150 per cent and our beef production about as much, since we let Dobbin out of the picture. The corn that was formerly fed to ten head of horses is now being fed to animals that return us a profit for it.

I want to say in closing that Forestdale Farm is being conducted on a strictly commercial basis. My goal is a balance on the correct side of the ledger. By applying business methods to farming, putting our labor into profitable channels and using tractor power which is the most economical power available, we have gradually brought the balance from the debit to the credit side of the ledger and should any of you be in the vicinity of Burlington, I would appreciate having you stop at Forestdale Farm and see how we operate a "horseless farm."

Economics of Farm Structures in a Southern Livestock Program*

By Deane G. Carter[1]

IN A study of buildings for southern livestock production we are confronted with a situation not comparable to conditions in northern or eastern states. The climate, number of animals, economic situation, and previous or hereditary methods are radically different.

We have no very definite background of design or construction either to follow or overcome. It is probable that our buildings represent extremes of low cost—cheap, inadequate structures on the one hand, and high-priced, unnecessary methods of construction on the other.

John Swenehart[2] calculates the investments for buildings per cow at $250 in Wisconsin. He characterizes the so-called "modern" barn as a hereditary design, a hold-over from the days when labor was cheap, materials plentiful and the big red barn was a symbol of prosperity and substantial citizenship. The question is raised as to whether or not we can justify a building expense of $15 or more per year per cow. J. L. Strahan[3] states however that low-producing cows will not return a profit, even if no building charge is made against them.

The obvious fact is that a research program will indicate the balance between expenditure and consequent production. For the housing of livestock we are justified in spending a sum sufficient to meet the requirements. In the South our poultry flocks do not need tightly closed, insulated and mechanically ventilated houses; swine housing is best accomplished by the lowest priced, individual structure. Beef cattle and sheep require shelter from wind and rain rather than complete and expensive housing.

However, the problem of livestock shelters is definitely before us—accredited poultry flocks; the southward movement of creameries and condensories; the necessity of supplementing our cotton production with other income; and the development of 4-H club work all demand more careful attention to our buildings. As engineers it is our duty to apply scientific methods to the design of buildings for economy. By economy is meant, of course, the use of the minimum of materials and costs to satisfy the essentials of the structure.

Research has been under way for a longer time and more progress has been made in production lines, and in other fields of agricultural engineering, than in farm structures. We are just now at the beginning of a program of development in structures that offers at once a privilege and a duty in southern agriculture.

At the very first we must divest ourselves of many traditional methods; of recommendations biased by hope of private gain; of "facts" based upon personal opinion. It might be well to question a number of things we have commonly accepted in structure design.

For example, why is it necessary to have 500 cu. ft. of space per animal? Is it for heat control in colder climate? Is it to provide sufficient air for ventilation? Where did the recommendation originate?

Why must the cows be put in a separate barn from the work stock, feed and hay? We have few cows per farm, few mules, and little feed. By no stretch of imagination can we recommend separate structures for all classes of stock.

Particularly, we must discard recommendations based upon northern conditions and specialized dairying conditions. We cannot extend the foundation of the barn four feet below grade; we cannot ceil the barns completely on the inside the stable; we cannot install controlled ventilation systems; we certainly cannot build the barn 16 ft. above the loft floor to the eaves; 16 ft. from the ground to the eaves would be ample. There are other accepted features of design that might be questioned especially for our conditions. Perhaps the most important step in the development of economical southern farm structures is a careful analysis of each design to determine requirements; simplify construction; reduce the amount of material needed; and find the minimum cost.

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*Paper (abridged) presented at a meeting of the Southern Section of the American Society of Agricultural Engineers, at Memphis, Tenn., February, 1928.

[1]Professor of agricultural engineering, University of Arkansas. Mem. A.S.A.E.

[2]Professor of agricultural engineering, University of Wisconsin. Mem. A.S.A.E.

[3]Agricultural engineer, Louden Machinery Company. Mem. A.S.A.E.

Recent Developments in Tillage Machinery*

By F. A. Wirt[1]

THE absorbing topic of conversation in agricultural circles the past few years has been the revolution brought about in the harvesting and threshing of small grains by the "combine." The spotlight of publicity has also been on the tractor, and just recently we are beginning to appreciate more fully what the use of the several hundred thousand tractors means to the welfare of the American farmer.

A revolution has also been taking place in tillage practices in many section of the country, especially in wheat-growing areas. To many the change which is taking place in tillage methods is virtually unknown. In the Southwest we have the wheatland disk plow. In the Northwest, Pacific Northwest and Canada we have the duck-foot or stiff-tooth cultivator and the rod weeder. For early cultivation of corn in the corn belt we find an increasing adoption of the rotary hoe.

As this last-named machine was the subject of a paper by R. I. Shawl, of the University of Illinois, at the annual meeting of the Society at St. Paul, Minn., in June 1927, there will be no further reference in this paper to the rotary hoe.

Neither the duck-foot nor stiff-tooth cultivator, the rod weeder or the rotary hoe are really new machines, for they have been on the market for some time, but have not obtained wide-spread use outside of certain limited areas, with the possible exception of the duck-foot cultivator in certain portions of Canada.

Part 1. The Wheatland Disk Plow

The wheatland disk plow, however, was sold on a large scale for the first time in 1927.

My understanding is that the early development of this type of plow originated with farmers in Kansas who built machines with wooden frames. The overnight popularity of this machine can best be appreciated when we consider the operations of wheat growing in the Southwest and the changes which have taken place. The combine has revolutionized harvesting methods in that section. Seeding of grain has become a rapid operation due to the tractor and wide grain drill. A few years ago harvesting was the peak of the year's work in growing grain in the winter wheat belt. The tractor, combine and wide grain drill completely changed that situation, so preparation of the seedbed has become the peak load and is the big factor in retarding the increase in the acreage grown per man. Former methods of preparing the soil were too slow for finishing large tracts while conditions were still favorable. The need for a faster, cheaper method of seedbed preparation brought about the development, manufacture and sale of the wheatland disk plow.

It should be explained that the names of this new revolutionary machine are many—wheatland disk plow, cylinder disk plow, great plains disk plow, one-way disk plow, disk tiller, and gold digger. It would be better for all concerned if everyone could agree upon one name.

Design and Construction

Examination of different makes of this type of machine clearly brings out the influence of previous development of disk plows and disk harrows. Many in the industry have likened the wheatland disk plow to the disk harrow, with all of the disks set to throw one way. In my opinion it should be considered as a new type of disk plow having such disk harrow features as gang bolts, spools, disk blades, etc.

The common sizes of this machine include the 10, 8 and 6-ft. widths; one manufacturer has removable sections so that the 10-ft. size can be reduced to 7½ ft., the 8-ft. to 5½ ft., and the 6-ft. to 4½ ft. In measuring the size of machine it should be noted that some manufacturers measure along the gang bolt, while others measure square across the strip of land plowed.

As to power required, an 18-32-hp. tractor can pull the 10, 8 and 7½-ft. sizes, depending upon the character of soil and depth of furrow. A 12-20-hp. tractor can pull the 8, 6 and 5½-ft. machines.

The disk blades used are usually 20 in. in diameter and they are set 6½ to 8 in. apart. Designers selecting the 6½-in. spacing have done so probably because of the influence of the disk harrow. The 8-in. spacing is based evidently on disk plow experience.

Advantages claimed for the 6½-in. spacing include (1) no large clods or lumps plowed up; (2) bottom of the furrow is left without scallops or corrugation; (3) all of the soil is moved.

For the 8-in. spacing it is claimed that there is far less clogging due to trash and, since the operation is one of plowing rather than of disking, the wider spacing is desirable for the same reason that on disk plows very seldom are disks set as close as 6½ in. apart. It is also claimed that, by proper adjustment of the hitch, the surface of the ground can all be cut, even when plowing shallow, just as well with the 8-in. spacing as with the 6½-in. spacing. Furthermore, it is said that the bottom of the furrow is ridged so slightly that for all practical purposes it can be considered plowed at a uniform depth throughout.

Trash guards can be attached to the framework for use in trashy fields, particularly where the trash is inclined to wrap around the spools.

The gang bolt holding the disks together is either continuous or in sections—two, three or four. If in sections, the designer usually arranges to have one section removable for stiff plowing. End thrust of the sections is absorbed by

Two views of a wheatland disk plow at work. It cuts and moves the soil without inverting the furrow slice

*Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, November, 1927.

[1]Advertising manager, J. I. Case Threshing Machine Co., Racine, Wis. Mem. A.S.A.E.

bearing construction peculiar to each make; also by the position of the wheels, these being set at an angle with the surface of the field. The gang bolt is set at an angle of about 60 deg. with the furrow.

To counteract sidedraft the wheels are set at an angle as already mentioned, the wheels being made with flanges which help to hold them in position, even in light soil. For many conditions it is very desirable to add wheel weights. These can be supplied for the land, front furrow and rear furrow wheels, although usually the extra wheel weight on the rear wheel is sufficient for the more difficult conditions. Wheel extensions are sometimes found necessary for plowing in soft ground.

Frame construction varies according to the ideas of the individual designers. On some machines most of the frame is in front of the gang bolt. With others the frame is largely above the disks. Many advantages are claimed for these two styles of construction, but there can be no question as to the importance of clearance in a machine of this kind.

Obviously the hitch is designed for tractor use. A connection between the hitch and front wheels makes it possible to turn either to the right or left with very little or no sliding of the machine at corners. The hitch is adjustable for different sizes of tractors. When in operation the right-hand wheels of the tractor run in the furrow to secure best results.

Most of the plows of this type are equipped with lever lift—one or two of them with power lift. It is difficult to predict what future development might bring in this connection, but considering the character of the fields plowed by this type of machine, it would seem as if the lever lift would continue to prove satisfactory.

Operation of Wheatland Disk Plow

Plows of this type do not turn or invert the furrow slice. When at work in a grain field its work is to mix the stubble with the soil. This action of mixing the stubble and soil leaves a ragged appearance which does not look so well at time of plowing but improves later on. Good contact is made between the moved soil and the bottom of the furrow slice. There are no ridges, no dead furrows and no hardpan or a smooth, hard surface at the bottom of the furrow. A clod mulch is formed not nearly so fine as that left by the disk harrow. Unlike disk plowing, the soil is not moved nearly so far. This is one explanation for the light draft of the machine compared to the amount of work done.

J. Leo Ahart describes the action of a plow of this type on the Missouri river bottom land of western Iowa thus: "On account of wet spring weather, the 57-acre field had lain idle and gone to weeds. The soil was very rich and the dense weed growth was as high as a man's head when the one-way disk plow entered it. Consider, if you will, the performance of the plow in this field. The plow cut 8 ft. in width. A three-plow tractor pulled it in high gear and the field (of 57 acres) was finished in two days. The disks were set to turn the soil to a depth of 7 in., and the manner in which the dense weed growth was covered out of sight was little short of marvelous. It would have required six days to do the same work with the standard tractor plow with three bottoms. There were no ridges or dead furrows in the field. This field will later be double-disked and fall wheat drilled into the ideal seedbed."

One unsuspected but satisfactory use of this plow, we are informed, is found in its performance in cornstalk ground where the owner intends to list corn. Former methods include the use of the disk harrow to cut up the stalks before listing. If a disk harrow was not used, some farmers first threw out the furrows with a lister, then busted the ridges with the same machine, planting the corn at the same time. It has been discovered that with a wheatland disk plow the soil can all be stirred to uniform depth and the stalks more effectively cut up. The heavier weight of the wheatland disk plow makes it possible to do a much better job of cutting the stalks.

Under favorable conditions the 20-in. blades can cut to a depth of 7 in. In the sections where this plow is adapted, a plowing depth of from 2 to 5½ or 6 in. is satisfactory. As a matter of fact, much of the plowing will be done at a depth of 3½ to 4 in.

Advantages of the Wheatland Disk Plow

For quickly covering wheat fields in the Great Plains area, there is nothing quite so satisfactory in performance as the wheatland disk plow. With a 10-ft. machine and tractor of suitable power, from 30 to 35 acres can be plowed in a day, while with a three-bottom 14-in. tractor plow under similar conditions approximately from 10 to 12 acres can be plowed. A rough comparison is to say that with the wheatland disk plow the operator can cover three times as much ground as he can with a moldboard plow, conditions being reasonably favorable.

In hard going a 3½-ft. section can be removed and the same tractor will operate with a 7½-ft. machine. With the 6 and 8-ft. wheatland disk plows, the acreage covered is in proportion to the size.

Until this new machine was introduced plowing was the slowest and most expensive of all operations in the growing of grain. Now this operation can be speeded up to an almost unheard of degree. This greatly reduces the cost of preparing the seedbed and is another factor in making it possible for a big percentage of the wheat growers of the Great Plains area to compete on a favorable basis with the grain growers of other states and other nations.

The draft of the wheatland disk plow is relatively light for the work done. Otherwise a tractor capable of pulling three, four or five 14-in. bottoms could not operate a 7½, 8 or 10-ft. wheatland disk plow. One explanation for this light draft has already been given; that is, the soil is moved a shorter distance and is not lifted up, as is the case with the moldboard plow.

Speed of operation brings with it another great advantage, namely, early plowing, which has been proven to be the most effective single treatment in producing high yields in the Southwest wheat fields.

In Bulletin No. 219 of the Kansas State Agricultural College, entitled "Growing Wheat in Kansas," appears the following statement: "One of the principal reasons for small yields and partial crop failures in Western Kansas is the large acreage in wheat and the poor and late preparation of the ground. Undoubtedly the situation could be greatly improved by introducing croping systems in which other crops besides wheat are used, or even by using better methods of growing wheat alone."

In Technical Bulletin No. 18 of the Kansas State Agricultural College, entitled "Tillage Investigations Relating to Wheat Production," it is brought out that control of weed growth during the summer is one of the principal beneficial effects in preparing land early in the summer. It is shown that if weeds are allowed to grow, the yield the following year averages 6.2 bu. per acre. If weeds are kept down by scraping, the average yield is 18.4 bu. It should be understood that in both instances the land is prepared by disking.

It is also brought out in this same bulletin that the greatest amount of nitrates in the soil at seeding time is found on those plots receiving some kind of early summer tillage. The probable explanation of the above is the absence of weed growth on early tilled fields.

It was further pointed out that since plowing in July produced an approximate yield of 27 bu. per acre, it is quite apparent that plowing is necessary for reasons other than control of weed growth.

Plowing immediately after the harvest is frequently resorted to with a wheatland disk plow to start the growth of weeds and volunteer wheat, and later the same field is plowed the second time to kill the weeds and volunteer wheat—also to leave the ground ready for seeding. In both instances the depth of plowing is around 3½ in.

Following grain harvest the surface of the soil is less protected from the sunlight; evaporation becomes more rapid; the soil is not in good condition for holding any water that may fall in the form of rain; weeds are likely to grow, consuming both moisture and plant food. So from the standpoint of moisture conservation, plowing with a wheatland disk plow is a splendid contribution to increased yields.

Due to the rough surface left by the plow, snow is caught and retained to a greater degree than is possible on a smooth

surface. This is very desirable for the wind-swept fields of the Great Plains area.

Prevention of soil blowing is another big advantage of this machine, for this has long been a serious problem in the Southwest. As already explained, the stubble is mixed with the soil and the surface is left rough. This cloddy surface prevents soil blowing, yet under many conditions one plowing of the field puts it in condition for the drilling of grain.

While the surface is left rough by the wheatland disk plow, yet it is level enough for the smooth operation of grain drills and of combines at the following harvest period. This is no small advantage, judging from remarks made by users.

As the plow can be set to cut any depth down to 6 in. or more, it is very easy to merely cut the surface, kill all volunteer wheat, destroy young weed growth and in every way keep the surface in good condition for drilling of the grain later on.

Experiment stations recommend that volunteer wheat be destroyed since it may become infested with Hessian fly, carry the flies through the winter and contaminate the fields in the spring. While planting at fly-free dates is desirable, yet everything possible should be done to kill the growth of volunteer wheat which may offer a protection to the destructive Hessian fly.

"Summer fallow consists of cultivating the ground and permitting it to lie idle for a season in order to conserve moisture for the following year," according to the bulletin entitled "Growing Wheat in Kansas," already referred to.

Summer fallow is becoming increasingly popular, particularly where the rainfall is not great enough to produce a large crop each year. A common practice is to summer fallow one-third of the land planted to wheat. To keep down weed growth and to conserve moisture the wheatland disk plow will be found very suitable and is used for this purpose in many sections.

These comments on the advantages of this type of plow would be incomplete without reference to other methods used in the same sections. For plowing hard ground, the disk plow is acknowledged more effective than the moldboard plow, although the latter is preferred wherever it can be used. Both the moldboard and ordinary disk plow, however, require plenty of power and considerable time to cover large acreages. Where difficulty is experienced with soil blowing, neither plow is satisfactory.

Because of these drawbacks, the wheatland lister has come into considerable use in the winter wheat belt. Listing is a faster operation; it prevents soil blowing; it leaves the fields in condition to catch the snow, but it has several disadvantages. When going through the field once, the soil is thrown up into ridges; only a portion of the soil is moved; much of the trash is left in bunches which do not decay rapidly enough. Frequently the ground gets too hard to list at the proper time. Then later these ridges must be split open. In this operation it very seldom happens that the ridge buster goes as deep as the original listing. Much surface is exposed to the sun. "Double listing in central and western Kansas is likely to so dry out the ground that a good seedbed cannot be secured," quoting again from Bulletin 219, entitled "Growing Wheat in Kansas."

One objection to the listing method is the uneven surface over which the combine must be operated the following season. In some sections today the wheatland disk plow is used immediately after harvest and the lister later. This practice, however, seems to be limited to rather small areas.

It is very likely that the wheatland disk plow will take the place of listers to a large extent.

Summing up the advantages, with the wheatland disk plow, the land can be plowed early with great rapidity immediately after harvest; a clod mulch will be formed; moisture saved; soil blowing prevented; weeds and volunteer wheat controlled. Because of these many advantages the wheatland disk plow is of real value to the Great Plains farmer and all others who can utilize this revolutionary tool.

With such advantages, it is not surprising that a large number of wheatland disk plows have been purchased by farmers in a comparatively short time.

Disadvantages of the Wheatland Disk Plow

In sod, gumbo, black waxy land, and rocky, stony fields, it is not likely that the wheatland disk plow will be found very satisfactory. In an effort to adapt this plow to more difficult conditions, heavier disk blades have been tried, but it should be remembered that the disk harrow has never become popular in stony fields. The reasons are not far to seek.

As the disks hit stones or rocks, they must ride over them. This lifts the gangs up so that very little work is done on the soil for some distance. Furthermore, there is the likelihood of catching a disk in a rock so that it breaks out a section of the blade. So under these conditions it is not likely that the wheatland disk plow will be used in quantity.

In the saw-fly areas of Canada, one control method includes the complete turning under of all stubble. As this is not practical with a plow of the type under discussion, it follows that the wheatland disk plow will not be satisfactory under those conditions.

At the present time wheatland disk plows are found from Texas to and including the western provinces of Canada. They are in use in Pennsylvania, Iowa, Illinois, California and other states. But in the main, this plow will be found most suitable for lighter soils where the owner does not wish to go too deep, say, over 5½ or 6 in., where there is not too much trash. The biggest field for this machine seems to be from Texas to Canada between the Rockies and the Mississippi River.

Final Report on Spray Coating Hazards

"SPRAY COATING" is the title of the final report of the Spray Coating Committee, Chemical Section, National Safety Council, recently issued. Spray Coating unquestionably involves accident and health hazards as is the case whenever an operator is brought into contact with harmful ingredients or impure atmosphere. This occurs even in brush painting, paint manufacturing, etc. In the past there has been no little controversy on the extent of these hazards accompanied by both understatement and exaggeration.

Realizing that in such a controversial situation there was considerable danger to progress and appreciating the necessity of securing authoritative information upon which to formulate a guide to minimize any hazards to life and health which might be present, the National Safety Council, through its chemical section, proposed that an investigation of spray coating be made under the auspices of a committee composed of representatives of groups interested in this subject and others who are qualified to give expert opinion.

The importance and value of spray coating was recognized and it was hoped that if serious hazards were revealed means of obviating them that would not interfere unnecessarily with industry would suggest themselves.

If the conclusions of the committee on spray coating, as contained in the committee's final report, are justified, it is safe in indoor work to spray materials containing appreciable qauntities of lead (over 2 per cent), benzol (over 1 per cent) or of free silica, when the worker is protected by:

(1) Adequate local ventilation producing an exhaust of 200 linear feet per minute. (Subsequent study may show that a lower velocity may suffice with improved operating conditions.)

(2) An efficient mask or respirator of the positive pressure type.

The committee recommends that, wherever practicable, materials free from lead, benzol, and free silica be used in spray coating.

Copies of the printed report are obtainable from the headquarters of the National Safety Council, 108 East Ohio Street, Chicago, Illinois. The price for single copies is $1.00.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

A Laboratory Method of Determining the Starting Properties of Motor Fuels, W. G. Lovell, J. D. Coleman, and T. A. Boyd (Industrial and Engineering Chemistry, 19 (1927), No. 3, pp. 389-394, figs. 11).—A laboratory method of determining the readiness with which an explosion may be obtained with any given fuel at the temperatures desired is described, which consists in measuring directly the air-fuel ratio necessary to produce an explosive mixture at any given temperature. Its application to the testing of a considerable number of fuels of widely different properties over a broad temperature range was found to yield results that are comparable with those obtained in starting tests on actual engines.

It was found that the effective starting volatility of a fuel does not change with the temperature similarly for all gasolines. This is taken to indicate the importance of making determinations of the effective starting volatility at somewhere near the temperatures that will be encountered in the actual starting of engines.

There appeared to be no direct relationship between the dew point of a fuel and its starting characteristics as determined by the experimental method. It was also apparent that there may be a considerable difference in volatility between two gasolines having almost identical distillation curves. The data are taken to indicate that distillation curves of the Engler type can not be of sufficient accuracy to make dependable estimations of relative volatility, especially at low temperatures.

Testing the Efficiency of Gas-Fired Warm-Air Furnaces, G. B. Shawn (Heating and Ventilating Magazine, 24 (1927), No. 10, pp. 65, 66, 74, figs. 2).—A new method of testing the efficiency of gas-fired warm-air furnaces developed at the testing laboratory of the American Gas Association is described and discussed. It presents the advantage of greater accuracy in measurement of air and heat output.

Wind Pressures on Structures, H. L. Dryden and G. C. Hill (U. S. Department of Commerce, Bureau of Standards Science Paper 523 (1926), pp. 697-732, pls. 3, figs. 20).—Part 1 of this paper is a general discussion of the subject, including a general survey of the effects of a uniform and steady wind and some consideration of the allowances to be made for the gustiness of the wind. Typical values of the coefficient of wind pressure are given for various types of models.

In part 2 wind tunnel experiments are reported on a square base prism 24.25 in. high with a base 8 in. square at wind speeds up to 70 mi. per hr. The pressure was measured at 70 points on one face and at 49 points on the top for wind directions varying from 90 deg. to one face to 90 deg. to the opposite face by 15 steps. The ground was represented by a fixed platform in one series of tests and by the tunnel floor in another.

It was found that the greatest average pressure against the building occurs when the wind blows normal to a face and is equal to 1.5 times the velocity pressure, that is, 22 lb. per sq. ft. for a true speed of 76 mi. per hr. The average decrease in pressure over the roof is about 0.84 times the velocity pressure, that is, 12.4 lb. per sq. ft. for a true speed of 76 mi. per hr. The maximum moment about a vertical axis is equivalent to a horizontal displacement of the resultant force of 0.077 times the width of the building.

Studies of Combustion in the Gasoline Engine, I, II, W. G. Lovell, J. D. Coleman, and T. A. Boyd (Industrial and Engineering Chemistry, 19 (1927), No. 3, pp. 373-378, figs. 10).—The first two contributions to the subject are presented.

I. Determination of rate of burning by chemical analysis (pp. 373-376).—As a departure from the usual methods of investigating combustion in gasoline engines, a study was made of the burning during its progress from a chemical point of view. The ordinary method of examining combustion by means of the engine exhaust is subject to the disadvantages that combustion occurs so long before the exhaust stroke that the final products do not give definite information as to how it has proceeded. It is considered important, therefore, to sample gases from the cylinder during the actual explosion period. For this purpose a special quick acting, water cooled sampling valve was devised, which makes it possible to follow the progress of combustion. This new experimental method was found to yield data particularly adapted for determining the rate of combustion. The knock is accompanied by an increase in the rate of burning of the gasoline, whether the detonation is caused by the addition of kerosene or by the presence of a chemical knock inducer. In the presence of tetraethyl lead gasoline was found to burn at about its normal rate.

II. The burning of hydrogen and carbon monoxide (pp. 376-378).—The results of the experiments indicated that simultaneous burning of carbon monoxide and hydrogen in a gasoline engine probably takes place according to the reactions

$$2H_2 + O_2$$
$$2CO + O_2$$

where the ratio of the velocity constants $k_{h_2} : k_{co} = 2.3$. Neither these reactions nor their relative rates are changed by a small increase in the compression ratio or by the presence of a knock inducer or a knock suppressor as long as detonation does not occur. The simultaneous combustion of two individual fuels in an engine at rates widely different for each does not appear to be in agreement with the concept of a narrow zone of flame advancing across the cylinder within which combustion is completed.

Irrigation in the Empire: Memorandum and Questionnaire, B. A. Keen ([London]: Empire Marketing Board, 1927, pp. 8).—A review of the status of irrigation in the British Empire is presented.

An Analysis of the Cost of Tile Drainage Installation on the Farm, H. B. Roe (Minnesota Station Technical Bulletin 47 (1927), pp. 82, figs. 25).—A mass of data on the cost of tile drainage installation on Minnesota farms is analyzed and presented in a form for ready use by agricultural engineers. It reports the results of investigations carried on from 1908 to 1921, inclusive, and considers rolling, flat, and peat land.

Engine Acceleration Tests, J. O. Eisinger (Journal of Society Automotive Engineers, 21 (1927), No. 2, pp. 184-192, figs. 12).—This is a progress report of work being done at the U. S. Bureau of Standards on internal-combustion fuels. The author first considers the general subject of engine acceleration and describes the test equipment and procedure used in the investigations. With reference to the degree of accuracy essential in such tests, attention is drawn to the determination of a change in engine torque of the order of 1 lb. ft. if a tachometer or a chronograph is used to determine acceleration. In this connection the smallest change in engine speed that could be detected by the equipment used was 2.5 r.p.m. per second, which is equivalent to a torque of about 2 lb.-ft.

The first series of engine tests consisted of a comparison of the maximum acceleration obtained with three different carburctors used without accelerating wells. One carburetor was of the plain tube type and the other two of the air valve type. These acceleration tests covered a speed range of from 250 to 1,000 r.p.m., and showed that the most important and pronounced lag in acceleration always occurs during the time the engine speed is increasing from 250 to 350 or 450 r.p.m. It was found that different carburetors may give marked differences in performance under normal temperature conditions. The plain tube type carburetor gave the best performance and the most consistent results. It appeared that the temperature of the cylinder walls has very little effect on the acceleration obtained. The acceleration obtained under a given set of conditions was found to be largely dependent upon the temperature of the intake manifold. With the particular gasoline used, an intake manifold temperature below about 78 deg. C. (172 deg. F.) caused a decided lag in the acceleration of the engine. The least lag in acceleration was found to occur when operating with rich mixtures.

The injection of various amounts of accelerating charge ceased to improve acceleration only in case the idling mixture was excessively rich. With a very rich carburetor setting the mixture delivered to the engine cylinders immediately after the throttle is opened may not become lean enough to affect acceleration materially, but such an adjustment gives a very high average fuel consumption. No consistent or significant difference attributable to the location of the accelerating jet could be detected when using the same quantity of accelerating charge.

Data are also presented on effect of sudden throttle opening and on flow of liquid in the intake manifold.

The Use and Duty of Water in the Salt River Valley, J. C. Marr (Arizona Station Bulletin 120 (1927), pp. 55-97, figs. 13).—Investigations conducted in cooperation with the U.S.D.A. Bureau of Public Roads on the use and duty of water in the Salt River Valley are reported.

The average gross duty of water for the valley is approximately 5.25 acre-feet per annum, and the net duty for all crops, as charged, is about 3 acre-feet. The difference consists of seepage and evaporation losses, water wasted in the operation of canals, and over-delivery. Alfalfa yields have been found to increase with the application of water up to a depth of 7 ft. per season, but a depth of 4 ft. is considered to be the safe quantity to use from the standpoint of protection from water-logging.

The results of observations on a limited number of cotton fields indicated that the yield increased with an increase in the water applied up to a total of 2.25 to 2.5 acre-feet per annum. The yield of sugar cane increased with the total annual depth of water applied up to more than 4 acre-feet. The quantity of water which should be used to irrigate small grain in this section has been found to vary from 1.4 to 1.8 acre-feet per acre per season. Grain sorghum should receive from 0.75 to 1.3 acre-feet of water per acre per season.

It has been found that border strips or furrows on the average soil of the valley should not be longer than 0.25 mi. and under some conditions should be much shorter.

A preface by G. E. P. Smith is included.

Electrical Cooking Appliances for Domestic Purposes, I, II, S. P. Smith, N. M. Macelwee, and J. G. Boyne (World Power, 6 (1926), Nos. 33, pp. 137-142; 34, pp. 197-204, figs. 6).—In the first part of this paper types of electrical cooking apparatus available for domestic purposes are discussed, with special reference to electric boiling plates and their testing. In the second part specific tests with boiling plates are described. Apparently the more important feature of these tests is the method of testing used, which indicates that the data from such tests represent actual conditions and apply to these conditions only, thus inferring that in efficiency tests of this nature it is difficult to lay down general basic principles.

The Theory and Practice of Modern Framed Structures, Part I, Stresses in Simple Structures, J. B. Johnson, C. W. Bryan, and F. E. Turneaure (New York: John Wiley & Sons; London: Chapman & Hall, 1926, 10., rev., pp. XIV + 356, figs. 288).—This is the tenth revised edition of Part I of this work.

Oil-Flow Through Crankshaft and Connecting-Rod Bearings, D. B. Brooks and S. W. Sparrow (Journal Society of Automotive Engineers, 21 (1927), No. 2, pp. 127-134, figs. 12).—Data are presented relating to the factors governing the flow of the lubricant through crankshaft and connecting-rod bearings. Apparatus for measuring the flow is described, and emphasis is placed on the fact that it permits measurement under operating conditions. Centrifugal force is shown to have a major influence on flow at high speeds, but it is pointed out that the magnitude of this influence can be controlled to a considerable extent by the radial location of the oil hole in the crank pin.

The Combine Harvester on Oklahoma Farms, 1926, J. O. Ellsworth and R. W. Baird (Oklahoma Station Bulletin 162 (1927), pp. 15).—The results of a study conducted in cooperation with the U. S. Department of Agriculture and the Texas, Kansas, Nebraska and Montana Stations are reported, including data on cost of operation, purchase price, labor, power, fuel, grain losses, equipment, repairs and the use of the combine for grain sorghum.

The 15-ft. combines were found to operate at an average cost of $2.09 per acre, the 7-ft. binders at $4.40, and the 12-ft. headers at $3.44 per acre. Costs per bushel for the entire group of States averaged 14 cents with the combines, 23 cents with the header, and 29 cents with the binder.

The combine crew range from one man with the 8-ft. machines to three men with the 20-ft. machines. The 20-ft. combines had the lowest fuel consumption per acre, and the 12-ft. machines the highest. The grain losses in the head only were 2.6 per cent for combines, 3.3 per cent for headers, and 6.1 per cent for binders. The grain tank was found to be economical when the threshed grain was hauled in trucks.

The costs for harvesting sorghum were 4.2 cents per bushel with the combine, 5.2 cents with the header, 17.5 cents with the row binder, and 11.2 cents with the hand topping method.

The Electric Brooder, B. D. Moses and T. A. Wood (California Station Bulletin 441 (1927), pp. 39, figs. 21).—The results of investigations on brooders heated by electricity in actual field operation are reported.

When radiation is depended upon as a method of heat transfer and the elements are operated at glowing temperature, the hover is generally from 3 to 4 ft. high, no curtains are used, and little or no trouble is experienced from sweating. The heating cost at 2 cents per kw-hr. was found to average from about 2.5 to 3 cents per chick per 1,000 hr. It was found that for mild climates 2 watts should be allowed per chick, but where freezing temperatures are experienced from 2.5 to 3 watts should be available.

In brooders using radiation but equipped with elements that do not glow, the hover is low, usually has curtains, and has some special provision for taking care of air replacement. The operation cost was found to be somewhat lower than with the glowing type. The heaters should have a capacity of from 1.5 to 2 watts per chick.

The brooders depending upon convection usually heat some or all of the incoming air, may or may not use curtains, may use either the glowing or nonglowing elements, are comparatively free from sweating troubles, and cost from 0.75 to one cent per chick per 1,000 hr. to heat. The open or curtainless type of hover requires more heat than the closed or curtain type, but it has better ventilation.

Seven square inches brooder floor area per chick is recommended.

Influence of Rust-Film Thickness Upon the Rate of Corrosion of Steels, E. L. Chappel (Industrial and Engineering Chemistry, 19 (1927), No. 4, pp. 464-467, fig. 1).—Studies conducted at the Massachusetts Institute of Technology are reported which showed that a very thick film of rust is required to decrease appreciably the corrosion rate of copper bearing steels, and that the more easily corroded steels have a much longer life when protected by even a thin film of corrosion product. This indicates the conditions under which copper bearing steels under water would not be superior to ordinary steel. On the other hand, it was found that where the rust film is removed copper bearing steels are likely to be more resistant. In addition it is concluded that the common practice of cleaning the rust accumulations from iron surfaces, such as inside water heaters and tanks, is likely to greatly increase the attack on the metal. In cases of heavy metals, such as cast iron, a thick film may be allowed to build up and corrosion be practically stopped.

Study of Air Velocity and Temperature in Vegetable Dehydration, A. W. Christie and K. Matsumoto (Journal of American Society of Heating and Ventilating Engineers, 33 (1927), No. 6, pp. 381-386, figs. 3).—The results of comparative experiments conducted at the California Experiment Station on the dehydration of carrots, cabbage, and peas are reported.

A temperature of 160 deg. F. was found to be approximately the highest safe temperature for the dehydration of carrots and peas, while for cabbage the temperature should not exceed 150 deg. While higher temperatures increase the rates of drying, they result in injury to the products. Air velocities in excess of 500 ft. per min. were found to slightly increase the rates of drying but showed a tendency to injure the quality of the products. An air flow of 500 ft. per minute at a temperature of 160 deg. gave the most economical use of heat.

Combustion Time in the Engine Cylinder and Its Effect on Engine Performance, C. F. Marvin, Jr., (National Advisory Committee of Aeronautics [U.S.] Report 276 (1927), pp. [2] + 16 + [1], figs. 17).—As a part of a general program to study combustion in the engine cylinder and to correlate the phenomena of combustion with the observed performance of actual engines, an outline is presented of what may happen in the engine cylinder during the burning of a charge.

A theoretical concept of a flame front which is assumed to advance radially from the point of ignition is presented, and calculations based on the area and velocity of this flame and the density of the unburned gases are made to determine the mass rate of combustion. From this rate the mass which has been burned and the pressure at any instant during combustion are computed. This process is then reversed in an effort to determine actual rates of combustion and flame velocities from the pressures as recorded on indicator diagrams. The effects of different rates of combustion on engine performance are also discussed, and the importance of proper spark advance is emphasized.

From a theoretical standpoint, from the analysis of indicator cards, and from observation of actual engines, it is considered evident that the time required for complete combustion of a charge varies considerably with different engine designs and operating conditions. It is also known that the rate of burning at any particular instant after ignition may differ even in cases where the total combustion time is the same. Both the rate of combustion and the time required for complete burning of the charge have an effect on the power and economy of the engine. The greatest power and economy are attained in the theoretical case of instantaneous combustion at upper dead center.

The slower combustions obtainable in practice may result in considerably reduced efficiencies if improperly timed with respect to piston position. However, the maximum theoretical performance may be approached very closely with a wide range of combustion times and rates, provided the proper spark advance is maintained for each particular condition.

Power Requirements of Electrically Driven Dairy Manufacturing Equipment, A. W. Farrall (California Station Bulletin 433 (1927), pp. 20, figs. 8).—It was found that the electric energy consumed by dairy manufacturing equipment may be determined by the use of suitable instruments, and that the cost of energy used in the processing of dairy products may be accurately calculated. The power requirements and energy consumption of a machine are largely affected by conditions under the control of the operator, and careful selection of the proper size and type of equipment is important if the best results are to be secured.

In the operation of a refrigeration machine of medium size under normal conditions a saving of 16 per cent in the cost of power may be expected when the head pressure is maintained at 150 lb. instead of 200 lb. per sq. in. The proper balancing of such equipment as churns was found to reduce strains in the motor and driving mechanism and to result in more economical operation.

No definite size of motor could be recommended for all types of ice cream freezers, as a large variation in power consumption was found with the different types as well as with various methods of freezing and kinds of ice cream manufactured. The stiffness to which ice cream is frozen should be closely controlled in order to prevent overloads upon the motor and driving mechanism, to reduce the cost of operation, and to secure uniformity in the product.

It was found that the relationship between the power consumption of the freezer motor and the stage of the freezing process is very close with many types of freezers. It differs in individual machines and is affected somewhat by variations in kind, age and ingredients of mix and the brine temperature.

Electrically heated dairy sterilizers were found to be practical and economical if properly designed and operated, and should be safe to operate when a small amount of water is used. For best results the sterilizer should be insulated with a double-walled air space and be equipped with a reliable thermostat or time switch.

Book Review

"How to Lay Steel Roofing" is the title of a new 100-page booklet just issued by the Sheet Steel Trade Extension Committee, Oliver Building, Pittsburgh, Pennsylvania. The booklet is a complete practical handbook which explains in semi-technical language the correct method for laying sheet steel roofing. It is the first booklet of its kind ever produced. In addition to the carefully prepared text matter, the booklet is profusely illustrated. All of the major steps in the use of steel roofing is illustrated with actual step-by-step construction pictures. It contains the following chapter headings: General information on steel roofing, corrugated roofing, V-crimp roofing, pressed standing seam roofing, self-capping roll roofing, galvanized steel flashing, roof drainage, and barn ventilators. Copies of this booklet will be sent free on request.

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RAYMOND OLNEY, Editor

Who's an Agricultural Engineer?

THE designation "agricultural engineer" is not confined to a limited group of persons in a particular field of effort. Broadly speaking, an agricultural engineer is an engineer whose function is the application of one or more of the fundamental branches of engineering—civil, mechanical, electrical, chemical—to the specific conditions and requirements of the agricultural industries.

An agricultural engineer is a person with an engineering training and an agricultural background. The profession of agricultural engineering is comparatively young, and most of those engaged in it, who hold engineering degrees, were originally trained in one of the fundamental branches of engineering. They are now properly agricultural engineers because their engineering training is specifically applied to the solution of agricultural problems.

The engineering profession in general, however, does not require that one calling himself an engineer shall hold a college degree in engineering. Likewise an agricultural engineer may not have an engineering college training; if he is successfully engaged in work of engineering grade—that calls for engineering requirements—he is recognized as meeting the requirements of an agricultural engineer.

The engineer engaged in the design and development of agricultural machines for a manufacturer of farm equipment is as much an agricultural engineer as the engineer employed on the agricultural engineering staff of a federal or state agricultural institution. The engineer employed by an electrical equipment manufacturer or a power company to develop the application of electricity to agriculture is as much an agricultural engineer as the consulting engineer employed by a farm owner to design farm buildings, or drainage, terracing and irrigation systems, etc.

In the membership of the American Society of Agricultural Engineers are men who were originally trained as engineers but who are now engaged in sales or advertising work. They are putting their engineering training to practical and substantial use; it is a real asset to them in their work. These men may be called sales managers or advertising directors, but primarily they are agricultural engineers.

Other A.S.A.E. members, trained as engineers, are operating farms and are applying their engineering in a most practical way. They may be farmers, but they are no less agricultural engineers. Tom Campbell, America's largest farmer, says farming is ninety per cent engineering and ten per cent scientific agriculture.

Briefly, an agricultural engineer may be said to be one who is making a substantial contribution to the development of agriculture along sound engineering and economic lines.

Our Who's Who

BEGINNING with this issue we are starting to present "Who's Who in Agricultural Engineering." Each month one page will be devoted to publishing the pictures of four agricultural engineers, including brief accounts of who they are and what they have contributed to the advance of agricultural engineering. The order of their "appearance" must not be taken as an indication of their relative importance or standing in the profession, as that would be impossible to arrive at by any selective process. For the most part they will be picked at random. However, the positions which they happen to hold at the time in the American Society of Agricultural Engineers will govern to some extent the selection of the monthly "quartet."

The agricultural engineers selected for our "Who's Who" gallery will, for obvious reasons, be A.S.A.E. members. One of the reasons, however, which may not be so obvious to one not a member of the Society and reasonably familiar with its membership, perhaps merits an explanation here. The fact of the matter is that practically without exception the recognized leaders in the agricultural engineering field are now A.S.A.E. members. And there is the further fact that they are the leaders and have gained their recognition largely because they were members. While the Society is a reflection of its individual members and their achievements, the Society in turn is an important factor in promoting the advancement and standing of its individual members. In other words, A.S.A.E. membership is a give-and-take proposition.

According to the old saying, "Birds of a feather flock together," and "one is known by the company he keeps." By the same token, a society is judged by its members. The American Society of Agricultural Engineers, to say the least, is proud to present its members, four by four, as a basis for judging the organization.

Let The Corn Borer Beware!

IF THE number of applications for membership being received at the headquarters of the American Society of Agricultural Engineers from agricultural engineers entering the employ of the U.S.D.A. Division of Agricultural Engineering to engage in corn borer control work—or the changes of addresses being received from members who are joining the control forces this spring—is an indication of what is in the air, the European corn borer is apparently destined to have a hard row to hoe. Or perhaps we should say "A tough stalk to bore." Anyway preparedness, in the shape of men, methods and machinery, is the order of the day, and Gray and his lieutenants are determined to push this year's campaign to a successful conclusion—"if it takes all summer."

What with other agricultural engineers—in the employ of the farm equipment manufacturers—developing and designing machines and equipment especially adapted to controlling the corn borer by mechanical means, certainly the borer will find the agricultural engineer has the upper hand at every turn.

It is a battle royal that is being engineered from 615 Front Street, Toledo, Ohio, the full significance of which no one can appreciate at this present time. While complete extermination of the borer appears to be out of the question, the control forces are demonstrating to the agricultural industry that it is possible to live with the borer and at the same time reduce losses to the minimum. There will result unquestionably improved farm practices that will in themselves justify the tremendous cost to federal and state governments of the war on the corn borer.

Who's Who in Agricultural Engineering

O. B. Zimmerman

Arthur Huntington

Thos. D. Campbell

H. B. Walker

O. B. Zimmerman

"Colonel" Zimmerman (Mem. A.S.A.E.) is president of the American Society of Agricultural Engineers. His regular job is that of experimental engineer of the International Harvester Co. He is a graduate in mechanical engineering from the University of Wisconsin, where upon graduation he served for several years as instructor and assistant professor in the college of engineering. For four years he was in the employ of the Hart-Parr Co., manufacturers of farm tractors, being promoted from draftsman to mechanical engineer in charge of design. He served two years in a similar capacity with what is now the Advance-Rumely Co. Since 1911 he has been in the employ of the International Harvester Company in various engineering capacities. He entered the military service in May 1917 as a captain of engineers; in October of the same year he was given a commission as major of engineers. He completed his military service in April 1919. In March 1924 he was given a commission as lieutenant-colonel of engineers in the Officers Reserve Corps. He has rendered agricultural engineering and the farm equipment industry an outstanding service along the lines of standardization and improvement of specifications on materials and designs of machine elements and products. Prior to his election as president of A.S.A.E., he served the Society as chairman of the Standards Committee.

Arthur Huntington

"Arthur" Huntington (Mem. A.S.A.E.) is first vice-president of the American Society of Agricultural Engineers. His bread-and-butter job, however, is that of public relations engineer of the Iowa Railway and Light Corporation, Cedar Rapids, Iowa. He is a graduate in mechanical engineering from Ohio State University. He has held important engineering and sales positions with the Westinghouse Electric & Manufacturing Co., Illinois Traction System, and others. He has held his present position since 1916. He is one of the pioneer and most enthusiastic exponents of the extension of the uses of electricity in agriculture. He was one of the original members of the Rural Lines Committee of the National Electric Light Association, which was chiefly responsible for the movement inaugurated by that association, in cooperation with the American Farm Bureau Federation, American Society of Agricultural Engineers, and others, to organize the Committee on the Relation of Electricity to Agriculture. His most outstanding contribution to agricultural engineering has been that of focusing public attention on the place and importance of the engineer in the industry of agriculture. His analysis of the relation of engineering to agriculture has been enthusiastically received by business leaders. In addition to his position as first vice-president, Mr. Huntington has served as chairman of the A.S.A.E. Rural Electric Division

Thomas D. Campbell

"Tom" Campbell (Mem. A.S.A.E.) is president of the Campbell Farming Corporation, Hardin, Montana. The magazine "Time" recently called him "The Biggest U. S. Farmer." He farms 100,000 acres of land. He was born on a North Dakota farm and is a graduate in mechanical engineering from the University of North Dakota and Cornell University. Taking up the battle cry "Food will win the war" in 1918, Mr. Campbell secured a lease from the U. S. Department of the Interior of 100,000 acres of dry benchlands in the Crow Indian Reservations in Montana. He then secured financial backing from J. P. Morgan and other bankers and proceeded to "manufacture" wheat on a large scale with mechanical power and modern machinery. He is typical of the new "agricultural industrialist." Of agricultural engineering he says, "Farming must be industrialized . . . . . The biggest industrial opportunity today is in agriculture. The largest field for technical men today is in agricultural engineering. In less than fifty years we will have a U. S. Farming Corporation larger than the U. S. Steel Corporation . . . . . In twenty years less than twenty per cent of our population will live on farms." The operations and equipment on his farm are organized and handled in a manner that would do credit to any industrial enterprise.

H. B. Walker

"Harry" Walker (Mem. A.S.A.E.) is chairman of the College Division of the American Society of Agricultural Engineers, and a past-president of the Society. He is professor of agricultural engineering and head of the department at Kansas State Agricultural College, Manhattan; however, on July 1 next he will assume the duties of head of the department of agricultural engineering at the University of California, and agricultural engineer of the California Agricultural Experiment Station. During the past year he served as director of the U.S.D.A. Survey of Research in Mechanical Farm Equipment, a function of the Division of Agricultural Engineering of the Bureau of Public Roads. Mr. Walker is a graduate in civil engineering from Iowa State College. Since graduation he has served in various engineering capacities, practically all of which have been in the land reclamation branch of agricultural engineering. During the World War he served as a captain of engineers in the 78th Division of the U. S. Army and in the A.E.F. as assistant division engineer on engineering operations; he saw service in the St. Mihiel and Meuse-Argonne offensives. Mr. Walker is a member of several honorary societies as well as state and national engineering societies. He has made a number of notable contributions to agricultural engineering literature. (A more complete account of Mr. Walker's activities appears elsewhere in this issue.)

A. S. A. E. and Related Activities

The 22nd Annual Meeting

THE 22nd annual meeting of the American Society of Agricultural Engineers will be held at the Hamilton Hotel, Washington, D. C., June 19 to 22, 1928. Preparations for this meeting have been in progress for nearly a year, and the committee in charge promises that it will be the most outstanding annual meeting in the history of the Society. If the preparations that are being made are any indication, the promises of the committee will in all probability be fulfilled. The annual meeting of the Society has for a number of years been the premier annual event in agricultural engineering circles. The meeting in Washington this coming June promises to be no exception.

Inasmuch as A.S.A.E. members are in the habit of arriving at the place of the annual meeting from one to two days in advance of the opening day, the day previous to the meeting, Monday, June 18, promises to be almost as busy and interesting a day as any of the four that follow. In addition to the large number of members arriving, securing their accommodations, renewing acquaintances and making new ones, etc., a number of important group meetings will be held, which cannot be accommodated during the days of the regular meeting.

Therefore, those who will attend the meeting and want to take every advantage of the opportunity to become acquainted with members of the Society and discuss matters of mutual interest, should plan to act on the local committee's suggestion to "go early and stay late."

The annual meeting will open on Tuesday, June 19. The entire day will be devoted to a program of the College Division, featuring problems in teaching, research, and extension in agricultural engineering of particular interest to members of the college group. The program of the division will be of particular value to members of the Society engaged in industrial and commercial pursuits, as well as those connected with the agricultural engineering staffs of the state colleges and universities and other public institutions. Representatives of manufacturers and associations of manufacturers attending this meeting should not miss the excellent opportunity afforded by attendance at the College Division session.

The first general session of the meeting will be held on the second day, Wednesday, June 20. In fact, the entire day will be devoted to the presentation of a program of interest to all agricultural engineers. The meeting will open with the address of welcome to be followed by the president's annual address. Speakers of national prominence with worthwhile messages to the agricultural engineering profession will appear on the program during the day.

The third day of the meeting, Thursday, June 21, will be devoted to programs of the four technical divisions of the Society—Power and Machinery, Rural Electric, Structures, and Land Reclamation Divisions. In order that these divisions may have more time for the presentation and discussion of problems of pressing importance in their respective fields, it has been found necessary this year to change the previous arrangement of having only two divisions meeting simultaneously, to giving each division the entire day for the presentation of its program. This arrangement makes it necessary that the four divisions meet simultaneously. In addition to the technical papers and reports of committees to be presented at these division sessions, a certain amount of time will be set aside for the discussion of division activities in a general way and the formulation of a program of work for each division that will result in well-coordinated efforts of all members and committees of the division.

The annual banquet of the Society—a never-to-be-forgotten event to those who have ever attended—will be held this year on the evening of Thursday, June 21.

The fourth day of the meeting, Friday, June 22, will be devoted to a general session of interest to all persons attending the meeting. The afternoon, however, will be given

Col. Zimmerman Breaks Ground for New Agricultural Engineering Building

This picture shows the esteemed president of the American Society of Agricultural Engineers, Col. O. B. Zimmerman, engineer, International Harvester Co., breaking the first ground for the new agricultural engineering building at Purdue University on March 15. From left to right, the group consists of G. M. Merwin, designing engineer, International Harvester Co.; Wm. Aitkenhead, professor of agricultural engineering and head of the department at Purdue; R. H. Wileman, research engineer in agricultural engineering at Purdue; Col. Zimmerman; David E. Ross, president of the board of trustees of Purdue University; and G. I. Christie, director of the Purdue University Agricultural Experiment Station. Construction work on this new building is now well under way, and it will be completed early this fall. Congratulations, Purdue!

over to demonstrations that will be of particular interest to agricultural engineers.

Walker Receives California Appointment

H. B. WALKER has been appointed head of the division of agricultural engineering of the University of California and agricultural engineer of the California Agricultural Experiment Station. He will begin his new duties on July 1, 1928. In July 1921 Mr. Walker was appointed professor of agricultural engineering and head of the department of agricultural engineering, Kansas State Agricultural College, which position he has held until the present time. During the past year, however, he was granted a year's leave of absence to serve as director of the U.S.D.A. survey of research in mechanical farm equipment which was undertaken about two years ago.

Mr. Walker is recognized as one of the country's leading agricultural engineers. He was graduated from Iowa State College in 1910 with the bachelor's degree in civil engineering; he received his master's degree in civil enginering from the same institution in 1920. He has held several important positions in civil and agricultural engineering work, and from September 1917 to July 1919 he served as captain of engineers in the U. S. Army. With the exception of two years on military leave he served as drainage and irrigation engineer with the extension division of Kansas State Agricultural College from 1910 to July, 1921.

Since 1910 he has also served as assistant state highway engineer, state irrigation engineer, associate professor of civil engineering, special consulting engineer of the U. S. Reclamation Service, engineer and later a member of the Kansas Water Commission, state supervisor of Kansas Committee on the Relation of Electricity to Agriculture, and consulting engineer of the State Fish, Game and Forestry Commission.

In the year 1924-25 Mr. Walker served as president of the American Society of Agricultural Engineers, and in that capacity represented the Society as a member of the assembly and administrative boards of American Engineering Council. He is at present chairman of the College Division of the Society and a member of the Research Committee. In addition he has served the Society on a number of important committee apointments. He rendered an outstanding service to the agricultural engineering profession and the farm equipment industry as chairman of the joint Committee on Cooperative Relations of the Society and the National Association of Farm Equipment Manufacturers.

In addition to being a member of the American Society of Agricultural Engineers, Mr. Walker also holds membership in the American Society of Civil Engineers, Kansas Engineering Society, and the Society for the Promotion of Engineering Education. He is author of a number of important publications.

Texas Student Branch Stages Auto and Machinery Show

MORE than three thousand people attended the automobile and machinery pageant put on by the student branch of A.S.A.E. at Texas A. & M. College on February 10.

Sixteen different lines of automobiles, including forty 1928 model machines, and an extensive line of motor trucks, tractors and up-to-date farm implements were shown.

This student branch has never before put on a show of this nature, but this first one was such a tremendous success that they plan to make it an annual event.

North Central Section Meeting

AS PREVIOUSLY announced, a meeting of the North Central Section of the American Society of Agricultural Engineers, comprising the membership of the Society in the states of Minnesota, North Dakota, South Dakota, Iowa, Nebraska, Kansas and Missouri, will be held at Iowa State College, Ames, Iowa, May 18 and 19, 1928.

The final program of this meeting has not yet been announced, but it is understood that important subjects to be presented include the utilization of corn stalks as a by-product, which will be presented by O. R. Sweeney, professor of chemical engineering, Iowa State College; the harvesting of corn stalks for manufacturing purposes, by E. V. Collins, agricultural engineer at the same institution; the combine in the North Central states; rural electrification, and the "L" concrete building block.

Requests for further information regarding the meeting should be addressed to R. L. Patty, South Dakota State College, Brookings, South Dakota, chairman of the North Central Section, or to E. A. Stewart, University Farm, St. Paul, Minesota, secretary of the Section.

Issues Booklet on Steel Roofing

ONE of the good advertisers of this journal, the Sheet Steel Trade Extension Committee, Pittsburgh, Pennsylvania, has just issued a very complete and practical treatise on how to lay steel roofing. The booklet is reviewed under the heading "Book Review" elsewhere in this issue. Anyone who has anything to do with the laying of steel roofing should have a copy of this booklet. A copy will be sent free on request to the Sheet Steel Trade Extension Committee.

Another booklet recently issued by this same organization deals with the use and application of steel roofing in a general way.

Issues Hitch Booklet

THE Horse Association of America has recently issued a 32-page illustrated booklet, describing various types and sizes of hitches for hitching mule and horse teams to farm implements. Hitches for from four to twelve horses are described and illustrated.

Copies of this booklet may be secured by writing to Wayne Dinsmore, secretary of the association, Union Stock Yards, Chicago, Illinois, and enclosing ten cents in stamps or silver.

Personals of A.S.A.E. Members

Wallace Ashby recently resigned as agricultural engineer of the Duluth & Iron Range Railroad, Meadowlands, Minnesota, and has joined the forces in federal corn borer control. He is now connected with the division of agricultural engineering U. S. Department of Agriculture, 615 Front Street, Toledo, Ohio.

R. H. Denman has resigned as agricultural engineer and instructor in Essex County Agricultural School, Hathorne, Massachusetts, to engage in rural service work with the New York Power & Light Corporation. His new address is 282 Yates Street, Albany, New York.

E. N. Bates, marketing specialist, U. S. Department of Agriculture, is inventor of the Bates laboratory aspirator for cleaning small grains and similar substances in small quantities for laboratory purposes. A public patent for the aspirator has been granted to Mr. Bates by the U. S. Patent Office. This permits the manufacture and use of the aspirator in the United States by any citizen, without the payment of royalty. Mr. Bates is joint author with George P. Bodnar of U. S. Department of Agriculture, Circular No. 9, December, 1927, which gives detailed information on the device and its use.

A. M. Goodman, extension professor of rural engineering, Cornell University, is temporarily engaged in drainage work for the Rockefeller Foundation in connection with their anti-malaria campaign in Porto Rico. The work is entirely under-drainage.

Max E. Cook, farmstead engineer, California Redwood Association, announces the arrival of a fine boy on February 22. Another potential agricultural engineer. Congratulations, Max!

A. H. Hoffman, associate agricultural engineer, California Agricultural Experiment Station, is author of Bulletin No.